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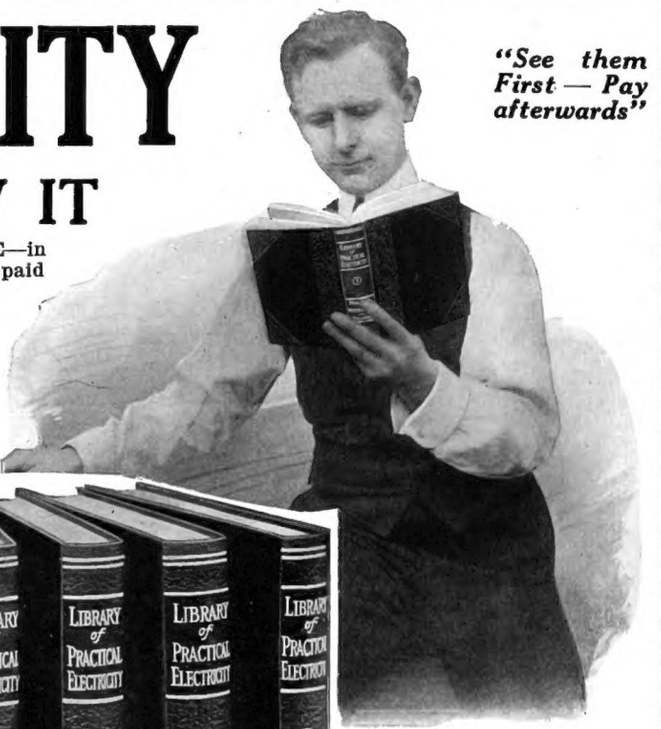

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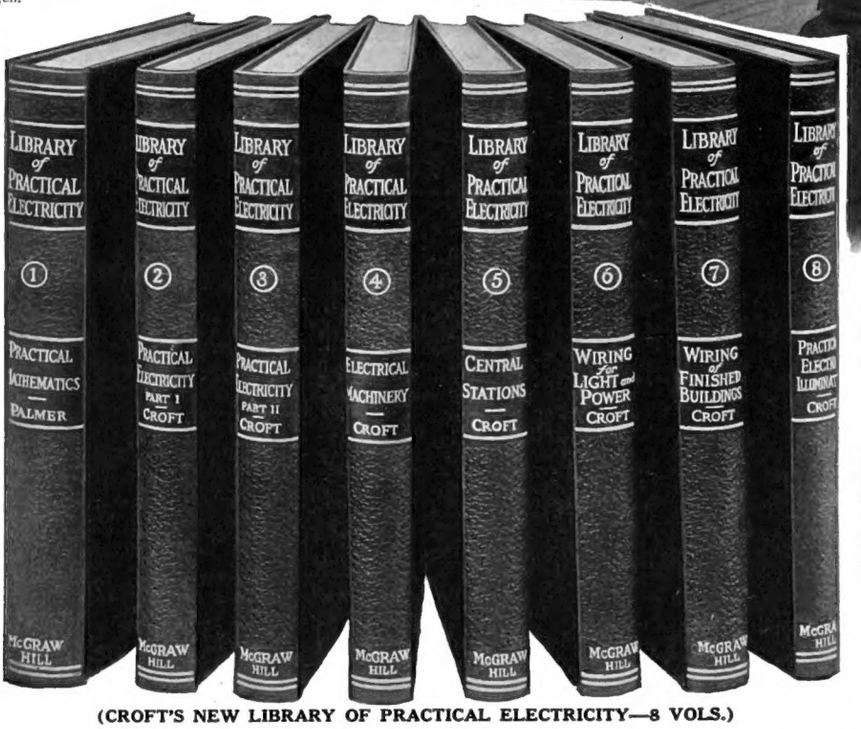
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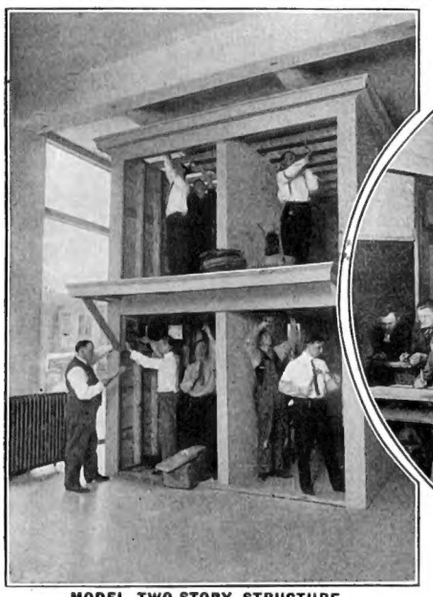

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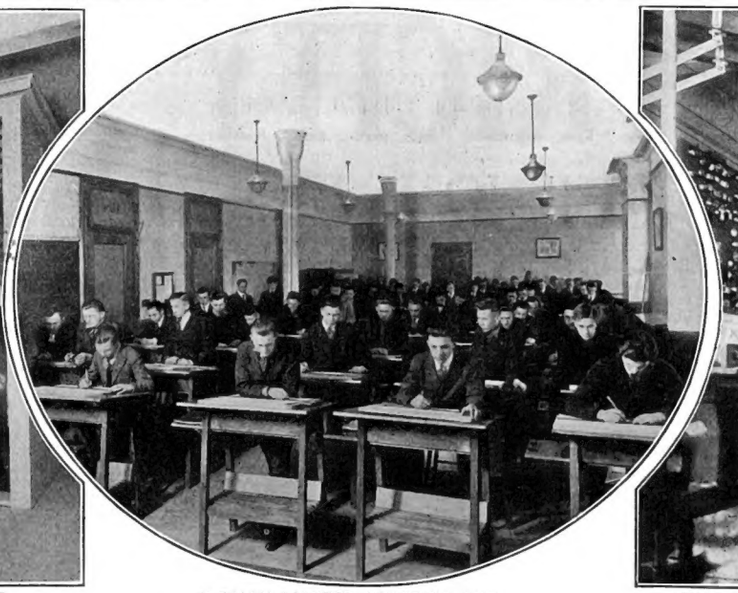

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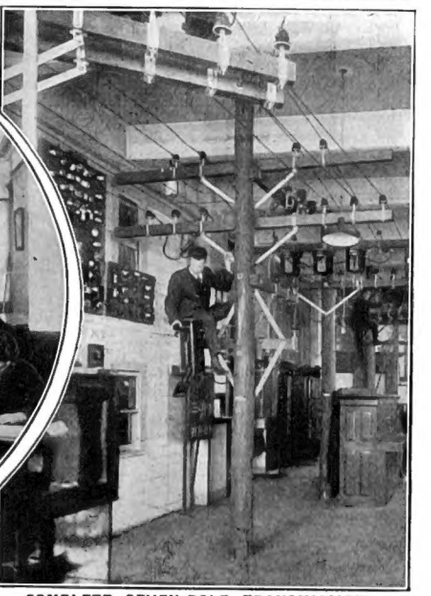

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EDITORIAL

COLD FROM ELECTRICITY

IF we pass an electrical current thru a metallic wire, the latter becomes heated. The thinner the wire and the larger the current, the greater the heat in the wire. All of our incandescent lamps work on this principle, as do our electric irons, toasters, water heaters, etc.

But few people know that electricity can and does produce cold direct, merely by passing from one certain metal to another. Nor is it a recent discovery. The device, termed "Peltier's Cross" after its French inventor, Peltier, was demonstrated in the middle of the last century. Briefly, the apparatus consists of two bars of metal, one being Antimony, the other Bismuth. The two bars are soldered together at right angles forming a cross. If we now pass a current thru the cross by connecting the positive pole of a battery to the Bismuth bar, and the negative pole to the Antimony bar, the point of junction between the two metals becomes rapidly cooled. If we drill a shallow hole into the top bar and fill it with water, it soon turns into ice, proving the experiment.

This phenomenon is of course well-known to the electrical man, but the very surprising fact is that it has never been turned into practical use during all these years. Of course, it goes without saying, that the original Peltier's Cross is not an efficient apparatus—it would be decidedly expensive in time as well as money to freeze ice cream this way!

But the principle is certainly there, and it is pretty well understood by the scientist; all it needs is improvement. And right here lies a wonderful gold mine for the man who turns out an economical electrical apparatus to produce cold commercially. Think of all the ice-less refrigerators, ice-less ice chests, ice-less ice cream freezers and what-not, for which we are eagerly waiting. Where is the benefactor who will lift the great American curse—ice water? Ice water is responsible for more ruined American stomachs, and for more dyspepsia than all the other causes combined. Water cheaply cooled to *near* the freezing point is what we need, so our doctors tell us. When will we see the first direct electrically cooled carafe, with its wire-covered net work, and a plug connecting it with the chandelier above the dining table?

And where is the still greater benefactor who will increase our working capacity one hundred per cent when the thermometer stands over 90°. During torrid spells, even in moderately hot weather, the entire world slows down. You simply can't work your best during the dog days, even if you happen to sit in a bathtub full of cold water, as I am doing just now, trying to write this Editorial! (The heat, by the way, furnished the idea for it!)

From late spring to early winter, millions of radiators stand idle all over the world. Why have we not sufficient intelligence to turn these perfectly good heating plants into cooling plants? The system is in the house and waiting, but we are too stupid to circulate freezing water thru it, and thus reduce the room temperature to 70° or less. A visitor from Mars would laugh his head off while walking into our offices where the already hot air is made still hotter by fans—which do not cool by the way, but increase the temperature. (Put your hand on a running fan—if it is not too hot—and you will know why fans do not cool a room.) Our visitor could not possibly understand why our radiators were hot instead of cold.

But we will not always be children. Some day we'll grow up and then we will know enough how to keep cool in summer, be it in the office, the house, or in the subway. But when that day comes, be prepared to shut all doors and windows, just as you do in the winter. If you don't your room will become hot just as it becomes cold in the winter, should you leave the door open.

Yes, and then we'll all have summer colds, to be sure!

H. GERNSBACK.

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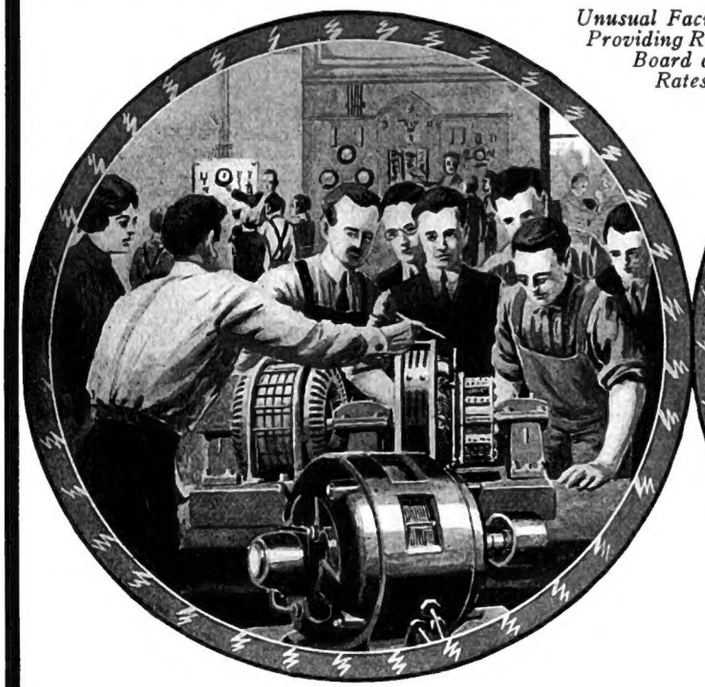

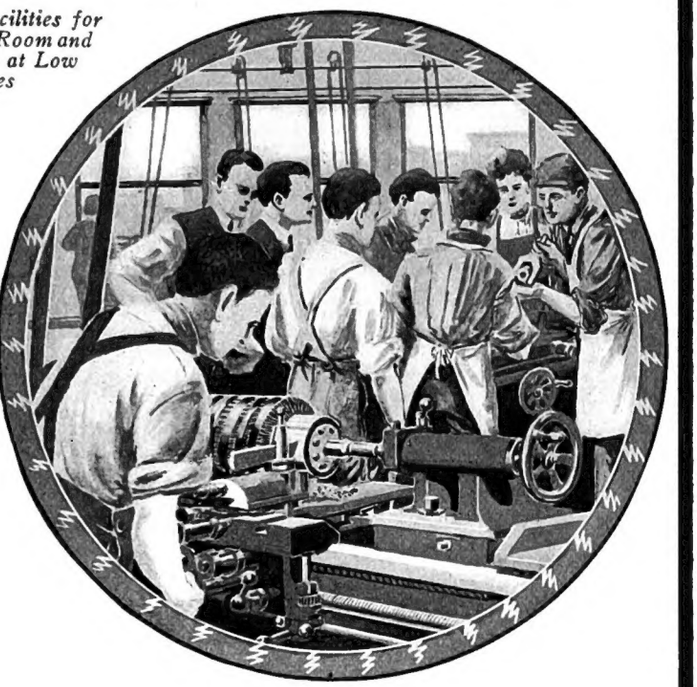

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Electrical Experimenter

H. GERNSBACK - EDITOR
H. W. SECOR - ASSOCIATE EDITOR

Vol. VI. Whole No. 65 SEPTEMBER, 1918 Number 5

How the Electric "Sea Tanks" Raided Pola

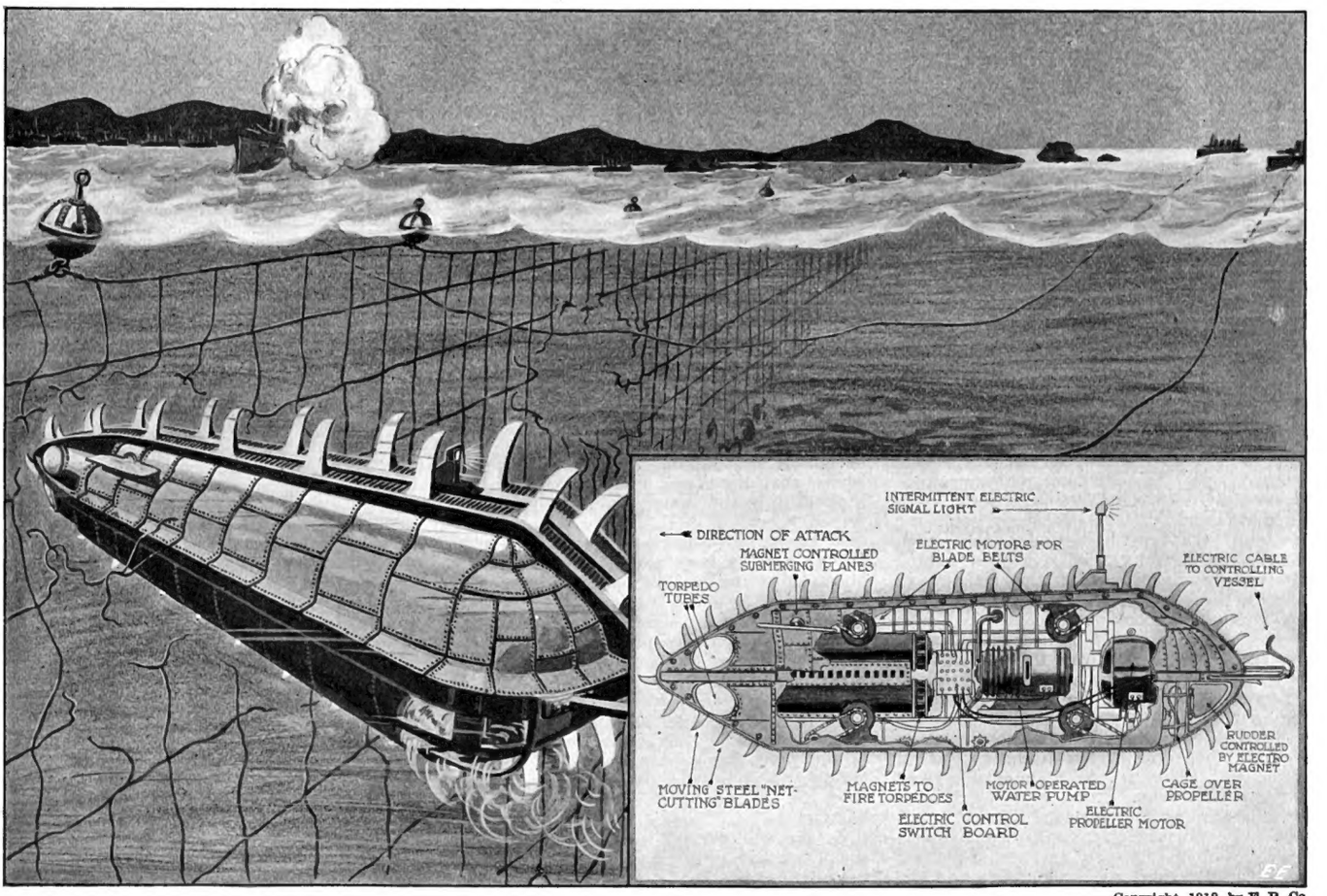
By H. WINFIELD SECOR

THE very latest war-time animal is the electric "Sea Tank" as used by the Italians in a recent naval raid on Pola, Austria's famous naval base.

From the information available on this latest hybrid among war-time offensive devices, it is learned that the Sea Tanks measure about forty feet in length and six feet in width, and that they are propelled by electricity. Further, as our illustration herewith shows, these Sea Tanks are provided with an endless rotary chain, running lengthwise around the vessel, these rapidly moving chains being fitted with sharp steel barbs or knives which can cut their way thru nets and other obstacles just like their prototypes, the land tanks, first used so effectively by the British. This under-water demon is provided with several torpedo tubes at the bow, and from all accounts, it seems that the device was crewless, and operated by means of electrical control currents sent thru a flexible insulated cable connecting with a war vessel, which latter nosed its way up to within a few miles of the steel nets guarding the harbor of Pola.

The account of the attack on Pola by the Italian Sea Tanks states that they bored their way thru the heavy steel nets spanning the navigable approaches to the port, within which there lay at anchor Austria's fighting fleet, and that a mighty Austrian battle-ship of the *Virubus Unitis* type of about twenty thousand tons displacement was torpedoed.

The detail illustration herewith shows the probable arrangement of the interior of the Italian Under-water Tank, also the arrangement whereby the steel belts carrying the net-cutting knives or barbs are driven by powerful electric motors, which obtain current from a storage battery carried in



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The Italian Navy Recently Carried Out a Remarkable Attack On Pola, Austria's Famous Naval Base, In Which the Latest Engine of War, The Electric "Sea Tank," Played the Leading Rôle. These Monsters with Their Net-Cutting Knives and Controlled by Electricity from a Mother Ship, Past Thru All the Harbor Barriers and Blew Up a 20,000 Ton Battleship.

How Artillery Observation Balloons 'Phone to Earth

When the artillery observers of our army in France, go up in balloons for the purpose of spotting the shell hits and correcting the ranges, they must have a positive and sure means of communicating with the artillery officers on the ground. The photograph herewith shows a telephone dug-out in France with two United States soldiers, who are in direct telephonic communication with the aerial observer above by virtue of a thin copper wire which runs up to the balloon basket. The work of the aerial balloon observer is more or less hazardous, and it not infrequently happens that the observer's balloon is shot down by an enemy shell, in which case he must use his wits and endeavor to make a safe landing with his parachute. On the other hand, it has often been remarked by officers who have had the opportunity of seeing service near the European battle - fronts, that these observation balloons will sometimes remain aloft and unscathed for days at a time. The work is extremely interesting and plenty of volunteers are always available. It takes a man of keen sight and quick perception to fulfil the duties of an observation officer, as the changes in range in some cases have to be made very quickly in order to bring about a certain military maneuver. We may safely entrust this task to Pershing's boys.

Photo © by Committee on Public Information

This Photograph Shows Two American Telephone Men In a Dug-Out In France, Carrying on Communication With an Aerial Observer In a Balloon. These Men Perform a Most Important Service In That They Control the Fire of the Artillery.

OBTAINING ELECTRICITY DIRECT FROM COAL GAS.

Electricity direct from coal gas is proclaimed as a possibility. According to the claims of a prominent New York engineer, the new process involves an electrolytic cell used as follows: The method is to dissolve in an electrolyte of fused borax the oxid of a metal such as manganese, which forms two or more oxides of different degrees of oxidation, and passes from a lower to a higher degree of oxidation when in contact with air, and from a higher to a lower when in contact with a reducing agent, such as fuel gas. When the solutions of a higher and a lower oxid are brought into liquid contact at any point a difference of electrical potential results, and if an appropriate electrode is immersed in each of the solutions a current of electricity will pass in a conductor joining them, so long as the difference of oxidation respectively in the two solutions is maintained. The current is about one volt, and from 15 amperes upward

Madrid gets its electricity for lighting and power from a hydro-electric plant 120 miles from the city.

An electrically equipt tremolo attachment for stringed instruments has been invented which produces the desired effects when buttons are prest.

the undersea craft, or from electric energy supplied thru the cable connected with it.

The electrical control cable in such devices as this, and where it is of any considerable length, is invariably coiled up and stored in the tank or torpedo, as otherwise the device would have to be extremely powerful in order to pull the constantly increasing length of cable thru the water if it were stored in a magazine on the tender ship.

It is entirely feasible for a device of this kind to be controlled by a warship of the destroyer class at a distance of seven miles or even eight to ten miles or more. With ingenuity and the proper design of the device of the type here under discussion, and also in consideration of the undoubted and proven cleverness of the Italian engineers, there is no doubt but what such a device could be sent out and steered so as to be submerged when it neared the steel nets and to bore its way thru them, and then to rise again; also at this juncture the observation officer on the war vessel looking thru his night glasses, could press the proper electric control button and cause one or more torpedoes to be discharged at an enemy war vessel in the manner described in the report from Rome, and which now forms a part of Italian naval history.

In any event, the Sea Tank would appear to prove an invulnerable antagonist against such war measures as harbor nets and the like, and it is conceivable that when designed to carry a crew, and providing the craft is equipt with powerful under-water searchlights, such a machine should prove highly effective in clearing out mine fields, and particularly such mine-infested waters as those leading up to the great German naval base at Heligoland. This maneuver by the Italian Sea Tanks in their attack on Pola may seem all the more practical and possible to the layman when it is considered that the entire Gulf of Venice is very shallow—about 120 feet at greatest depth—and such an underwater fighting monster might crawl even along the bed of the Gulf of Venice and tackle the steel nets and mines protecting Pola, much in the same manner as a gigantic turtle would crawl along the bed of a lake. In fact, some engineers venture the opinion that with the proper design of the moving caterpillar belts and barbs, that the Tank could be made self-propelling in the same manner as just mentioned.

It is most probable however, that the Italian Sea Tank as now used is fitted with powerful propellers the same as the submarine, and also that it has a suitable rudder for the purpose of steering it. To prevent the cable from becoming fouled in the propeller blades, the latter are encased in substantial steel cages. The pilot light or lights are provided with shields at the front, so as to throw intermittent signal flashes sternward, and by arranging this on a telescopic mast the officer in charge can, by simply pressing the proper button, cause them to rise ten to fifteen feet above the back of the Sea Tank while it is progressing thru the water near its objective. When the Tank has progrest sufficiently near the net or other obstruction it is to burrow thru, the proper electrical impulses are sent over the electrical control cable which starts up the water-ballast tank motor, and by filling the tanks, the craft is caused to submerge It is a simple matter and one which has been used heretofore to provide a suitable electrical *position indicating* arrangement, whereby it becomes possible to know at any instant the direction and location of the "Sea Tank" while it is submerged. By means of a sensitive microphone installed in the vessel, it would be possible to ascertain when the Tank had chewed its way thru the enemy nets, and it could then be caused to approach the surface again if so desired. It is not however, imperative that the vessel be made to come to the surface so as to show the signal light, for by means of the position indicating apparatus just described, its exact position at any moment could be known and torpedoes discharged from it at an enemy war vessel swinging at anchor within the netted area.

U. S. PATENT OFFICE NEEDS EXAMINERS.

The U. S. Patent Office announces a need for technically trained persons for the examining corps of the Patent Office. Men or women are desired who have a scientific education, particularly in higher mathematics, chemistry, physics, and French or German, and who are not subject to the draft for military service. Engineering or teaching experience in addition to the above is valued. The entrance salary is $1,500.

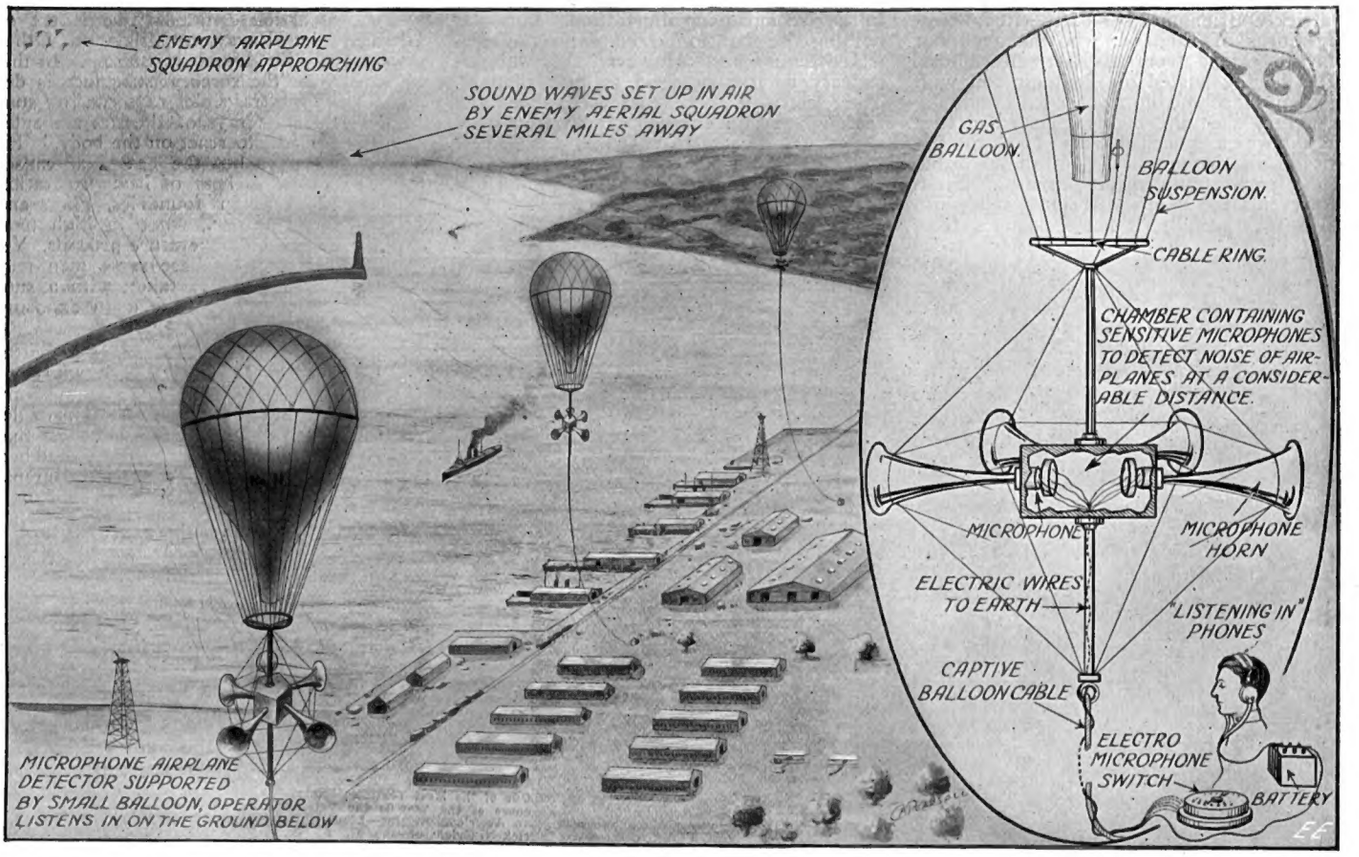
Examinations for the position of assistant examiner are held frequently by the Civil Service Commission at many points in the United States. One is announced for August 21 and 22, 1918. Details of the examination, places of holding the same, etc., may be had upon application to the Civil Service Commission, Washington, D. C., or to this office.

Should the necessity therefor arise temporary appointments of qualified persons may be made pending their taking the Civil Service examination. Application for such appointment should be made to the Commissioner of Patents, Washington, D. C.

Balloon Microphones to Warn of Air Raids

By LEE A. COLLINS

IN the scheme of aerial raid warning here proposed balloons are sent up and held secure by means of a strong rope or cable. Sensitive electric microphones are fastened to the under-harness of the balloon. All of the sound detectors are in series with a telephone receiver and a source of electric current by means of two wires which lead down by the cable.


ENEMY AIRPLANE SQUADRON APPROACHING
SOUND WAVES SET UP IN AIR BY ENEMY AERIAL SQUADRON SEVERAL MILES AWAY
MICROPHONE AIRPLANE DETECTOR SUPPORTED BY SMALL BALLOON, OPERATOR LISTENS IN ON THE GROUND BELOW
GAS BALLOON
BALLOON SUSPENSION
CABLE RING
CHAMBER CONTAINING SENSITIVE MICROPHONES TO DETECT NOISE OF AIRPLANES AT A CONSIDERABLE DISTANCE
MICROPHONE
MICROPHONE HORN
ELECTRIC WIRES TO EARTH
"LISTENING IN" PHONES
CAPTIVE BALLOON CABLE
ELECTRO MICROPHONE SWITCH
BATTERY

A Number of French Cities Are Equipt With a Specially Sensitive Microphone "Listening-Posts" Placed On High Buildings or Other Elevated Structures, for the Purpose of Detecting the Approach of Enemy Aircraft. An American Inventor Here Proposes a Very Simple and Feasible Plan for Giving Aerial Alarm Protection to Our Towns and Cities. The Scheme Is Simple, Involving the Use of Small Balloons Which Carry a Series of Horns Pointing in Various Directions, Each Horn Being Connected With a Super-Sensitive Microphone; Each Microphone Is Connected By Its Wire to Earth, Where a Selective Switch and a Pair of Listening 'Phones Enable the Operator to Quickly Ascertain Which Microphone Is Being Actuated, and Thus Also From Exactly What Direction the Enemy Aeroplane Squadron Is Approaching. These Microphones Will Indicate the Approach of Aircraft Several Miles Away.

Balloons can be sent up all along our coasts or cities at suitable distances apart. In case an enemy aeroplane attempts to bomb our cities, the sounds of his aeroplane engine are caught by the sensitive microphone detectors and are heard thru the telephone receivers. One central listener could keep the receivers fastened to his ears and receive the alarm from all of the detectors, or a listener could be kept for each district that the balloons were guarding. A galvanometer indicator can be used instead of the receivers to give a signal of approaching enemy aeroplanes. The range of detection will probably be greater than most people estimate, as tests made with microphones in locating pieces of artillery have proved.

SOUND-RANGE TELEPHONES TO LOCATE GUNS.

Upon his return recently from the battle front in France, Major-General J. Franklin Bell in supplying information to the Senate Military Committee reports as one of the greatest scientific achievements of the war, the telephone arrangement whereby the position of enemy guns is determined. A portion of General Bell's statement follows:

All armies now employ scientific methods of locating guns which have never been employed in warfare before. One is known as the sound-ranging method. Briefly, they have observers scattered along a curved line, which has been accurately measured, and all of these observers, of whom there are usually six, utilize electric sound-ranging apparatus by which they report instantaneously the moment they hear the sound of a gun explosion. At a central point another electric apparatus records these sounds from the six different stations, and by a scientific method they combine the knowledge gained from these six points and succeed in locating with a remarkable degree of accuracy the position of the gun that made the explosion when it was fired.

Each side has a type of telephone which is able to hear distinctly over very considerable distances conversations not intended for the listener, and for a long time the Allies employed this system of gaining information without the knowledge of the enemy; but the Germans captured one of these instruments and discovered that their conversation in the trenches had been listened to for quite a while and that the Allies had thus gained some information in a way which had long puzzled the Germans.

MARCONI 11,000 K. W. BUENOS AYRES RADIO PLANT.

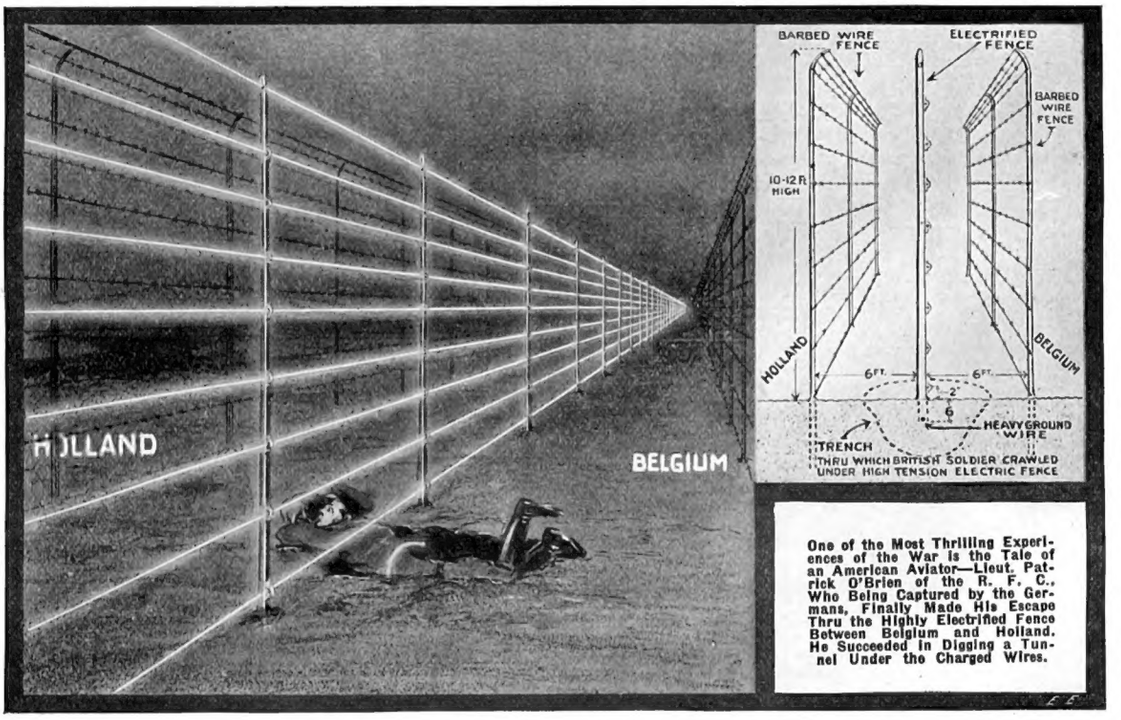
The Marconi Company is to erect the largest wireless station in the world near Buenos Ayres. Edward J. Nally, vice president and general manager of the company, has just closed a contract for the installation. The power of the new station, it is announced, will be 11,000 kilowatts, and three towers will be erected, each the size of Eiffel Tower.

IMPROVE NAUEN WIRELESS PLANT.

The German wireless station at Nauen has been greatly improved since the outbreak of the war, according to the *Frankfurter Zeitung*. Instead of a single transmission tower 300 feet high, it now has ten towers ranging in height from 890 feet to 360 feet, while the distance thru which messages can be transmitted has been extended to 6,200 miles. The Frankfurter paper is quoted as saying that the Nauen services have proved invaluable for instructing cruisers and U-boats and that both the Goeben and Breslau received thru Nauen instructions to steam into the Bosphorus.

American Aviator Escapes Under Hun Electrified Fence

HOW would you like to be captured by the Teutons, and after escaping from your captors, not to mention sleeping in swamps and woods by day, and subsisting on fruits and raw vegetables, finally reach the border line which meant your liberty, only to find that a deadly electrified wire fence stared you square in the face? Such was the experience of an American flier, Lieutenant Patrick O'Brien, member of the Royal Flying Corps of England, who managed not only to escape from his German captors, after having landed on Teutonic soil with his flying machine, but succeeded eventually in getting past the highly charged electric fence which guards every foot of the border land between Belgium and Holland. This fence serves three purposes. First, it prevents the Belgians from escaping into Holland; secondly, it keeps enemies from making their way to freedom; and thirdly, it prevents desertions on the part of German soldiers themselves.



One of the Most Thrilling Experiences of the War is the Tale of an American Aviator—Lieut. Patrick O'Brien of the R. F. C., Who Being Captured by the Germans, Finally Made His Escape Thru the Highly Electrified Fence Between Belgium and Holland. He Succeeded in Digging a Tunnel Under the Charged Wires.

The accompanying illustration shows one of the most remarkable experiences ever enacted by a war-tortured human being. When Lieutenant O'Brien finally emerged from his last hiding spot in the woods near the Holland border, he nearly ran into this electrified barbed wire barrier before he knew it, altho he had previous knowledge of it.

The hero of our story first thought of trying to make a grand pole vault over the whole three fences including the central electrically charged one, but this idea was finally dropt as the triple fence covered a span of at least twelve feet, and in order to safely clear the last barbed wire barrier he would have had to vault at least ten feet high and fourteen feet across. With the possibility that if the pole ever slipt he might be thrown on the charged wire and immediately electrocuted when in falling his body would establish the circuit between fence and ground.

Another idea which he unsuccessfully tried out was a ladder which could be placed against one of the fence posts, and this he built from small twigs and boughs which he found in the woods near the fence and bound them together with flexible twigs and strips from his underclothes.

Eventually Lieutenant O'Brien hit upon the idea which finally saved his life and gave him his liberty, and his plan is shown in the accompanying illustration. This was nothing else than to *burrow under the electrified wire fence.* However, this was not as easy as it may seem at first thought. The electrified fence measured about ten feet high and the charged wires were spaced about ten inches apart while the lowest charged strand was but two inches from the ground. This is not all, for when our brave Lieutenant had dug a considerable quantity of the soil away with nothing but his bare hands, he discovered a heavy underground wire about six inches below the surface of the ground. He had great difficulty in digging the earth away without being discovered by the sentry who walked up and down periodically along the German side of the fence, and again, the underground wire, which was as thick as a man's finger, would not give.

But Yankee pluck and courage finally won, and by tugging at this wire, which did not carry any charge but served merely as a guard wire against just such an escape as this, he caused the underground wire to give at several points along the fence. He then proceeded with extreme caution to crawl feet first and on his stomach thru the trench which he had dug with his hands. His nerves were none too good, but he knew that one false move of even one inch, would mean certain death, and in a few moments he successfully made the passage under the heavily charged wires and emerged into the final space between the central electrified fence and the final barbed wire which was the only remaining barrier between himself and his liberty. He kneeled down and offered thanks to his Maker for his miraculous escape, and a few minutes later he past safely between the strands of the final barbed wire into Holland.

GENIUS AND ULTRA VIOLET RAYS.

By J. Marchetti

In a back number of the E. E. there appeared an article entitled "The Effect of Ultra Violet Rays on Milk and Other Aspects," by Dr. Humbert Bizzoni. In this he says that "the cerebral substance is decomposed by ultra violet rays causing sunstroke, when the rays of the sun are sufficiently powerful to react on the body." He shows that it is not the heat that causes this, for we never hear of heat prostration "among workers in foundries, glass and pottery factories, etc., where a high temperature prevails. Yet these same men may be taken with a sunstroke upon exposure to the sun."

Still it is a matter of surprise when we read in the memoirs and confessions of deceased geniuses that they accomplished better work in the intense sunlight. In fact some of them could not work unless the sun's rays fell on their bare heads.

No doubt, the question has often presented itself to many, why many men of genius have preferred or had to compose in the scorching rays of the sun. But may we not find an answer in Dr. Bizzoni's discovery. And when we see that genius and madness grows in the same pot, according to C. Lombroso, and that post-mortem examinations have shown degenerations of cerebral matter of many great men of this type the conjecture becomes more convincing. As the sunlight is rich in violet rays and they are capable of decomposing the cerebral substance, consequently they acted for such men as stimulants. We all know that many famous men have resorted to narcotics and other stimulants in aiding them in their creative works. So for these individuals the ultra violet rays acted as creative aiders by effecting chemical changes akin to narcotic stimulants.

Also, light vibration acts therapeutically by its penetration. But in the case of these men the dissolving power of the ultra violet rays was of greater consequence.

Among such "Sun Fiends" we find Rousseau, Lesage, Giordani, etc. Rousseau said that the action of the sun in the dog-days aided him to compose and he allowed the rays of the mid-day sun to fall on his head. The striking fact is that Rousseau's brain showed, after death, a marked degeneration of one of the lobes. Lesage, in his old age, became animated as the sun advanced to the meridian, gradually gaining

(*Continued on page* 351)

Making Synthetic Gems in the Electric Furnace

By GEORGE HOLMES, Asso. A. I. E. E.

THE history of jewels and the thrilling part they have played in the world's history would make the "Grimm's Fairy Tales" fade away into oblivion. Kings, Queens, Sultans and entire Kingdoms have been wrecked thru the many intrigues and mysteries that have been connected with famous jewels of ancient times. There was Caesar, Anthony and Nero and the havoc they wrought on Rome and the splendid cities of the far famed east; not to mention Cleopatra, the charming Queen of the Nile, who put the skids under a number of happy rulers just because she was the best drest woman in Egypt and changed her jewels seven times a day.

For centuries it was necessary to mine these wonderful gems, by the sweat of the brow; but now all this is changed for to-day in the very heart of New York City, an expert electro-chemist in the person of Dr. Maurice Aisen is making precious stones with the aid of the electrical furnace that bid fair to rival all those of ancient times.

There are more large and beautiful diamonds in the world today than rubies and this has a curious explanation. Ages ago in India the Rajahs gave the privilege of mining to their subjects with the proviso that all gems above a certain size were to be sent to the Rajahs themselves. As a result, whenever a large stone was found it was broken by the miners, only an occasional one being sent to the Rajah to insure the continuation of the mining franchise. At that time jewels were cut and polished by rubbing them against each other. It was not until the fifteenth century that the present rotating wheel method of polishing them was introduced.

In the olden days the manufacture of a perfect stone was a long and tedious operation. To-day it is a fact that jewels can be analyzed, the component minerals found, then the same proportion of ingredients assembled and *synthetic jewels* actually manufactured, which equal Nature's own product.

Some of the earliest experiments in artificial or synthetic jewel making were performed in Dr. Aisen's student days in the University of Paris. One day Prof. Henri Moissan, his instructor and world famed chemist, found diamond crystals in the meteor. The meteor was one which had fallen in Arizona and was shipt immediately to the University of Paris for examination. Out of the discoveries of the pure carbon or diamond crystals that the meteor contained, conclusions were formed that it was chiefly a *combination of heat and pressure* that made jewels.

Dr. Aisen at this point became deeply interested in gem making; and analysis of the component minerals in various jewels followed, including various tests as to the proper application of heat and pressure. In his laboratories Dr. Aisen has formulas which can produce almost all known jewels and semi-precious stones, the only exception being so far the diamond.

After a gem has been analyzed and its component minerals found, the same proportion of ingredients are assembled and put into crucibles where they are raised to the required temperature and then are suddenly cooled. There are a number of methods used to obtain the desired high temperature necessary in this marvelous twentieth century work. Among the first is the oxygen-hydrogen flame. Various types of electric furnaces are now used and

(*Continued on page* 354)

Manufacturing Precious Stones in the Electric Furnace: 1—Dr. Maurice Aisen at Work Making a Synthetic Gem in the Fierce Heat of the Electric Arc—the Greatest Heat Known to Science. 2—One View of the "Gem Making" Laboratory. 3—Another View of Dr. Aisen's Workshop, and 4—a Close-Up Glimpse of a "Battery" of Electric Furnaces in Which Rubies and Emeralds Are Turned Out by the Hundred for the Jewelry and Allied Trades. The Evolution of These Synthetic Jewels is Illustrated by the Small Border Views. They are "Roughed Out," Ground and Polished the Same as Regular Gems. Diamonds Have Been Made in the Electric Furnace, But the Synthetic Diamond Cannot Be Manufactured Economically Just Yet.

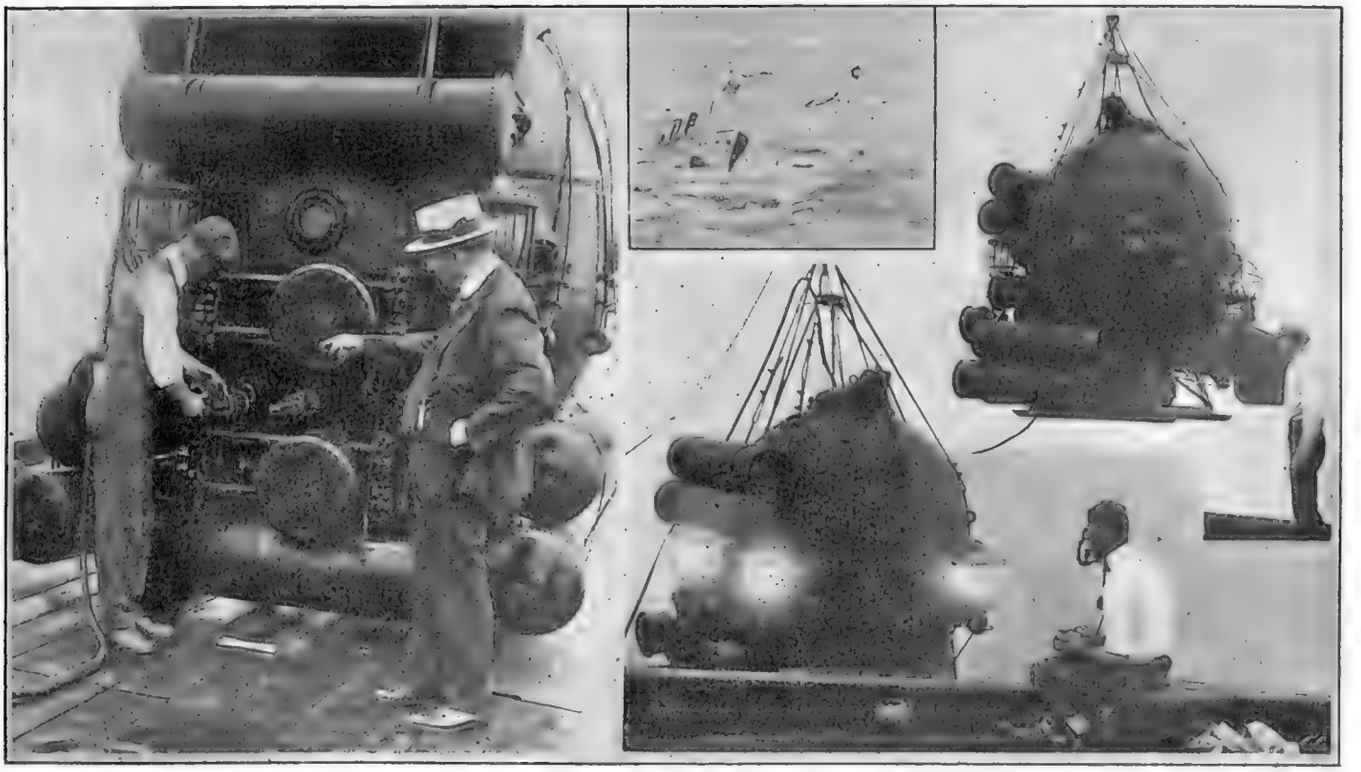
Test Diving Machine to Undo U-Boats' Work

A DEEP sea diving machine designed for use in raising torpedoed vessels was tested in Long Island Sound off New Rochelle, N. Y., recently. Its inventor, W. D. Sisson, has asked for a Government trial.

The machine, propelled by an electric motor, went down ninety-eight feet, bored holes in a steel plate, inserted riveted and brought the plate to the surface. It was manipulated by two men inside. The current was furnished from a barge. Its inventor asserts that the machine can be used to fasten water filled pontoons to sunken ships. Then, when the pontoons are emptied, the ships will be brought to the surface.

Propellers on the bottom for moving up and down and two on the side for propulsion forward and backward, make the machine easy to maneuver. It is nine feet long, seven feet, six inches in diameter and weighs nine tons.

Powerful magnets on the outside hold the machine against the ship into which rivet holes are bored. Small glass portholes permit the machine crew to see what they are doing. Strong electric lamps light the water for them. There is equipment for expelling exhausted air and pumping water from the ballast tanks. Communication with the barge was maintained by telephone. One of the photos shows the inventor and a member of the crew inspecting magnets and drills. A second photo illustrates the diving and salvaging machine ready for a plunge beneath the waves, while the third photo shows the machine going down, with lights lit and telephone communication established with the barge. The telephone operator on the barge manipulates the necessary switches.



This Deep Sea Diving Machine, Intended for Use in Raising Torpedoed Vessels, Was Tested in Long Island Sound, New York, Recently With Success. The Device, Propelled By An Electric Motor, Went Down Ninety-Eight Feet, Bored Holes in a Steel Plate, Inserted Rivets and Brought the Plate to the Surface. Its Crew is in Constant Telephonic Connection With the Salvage Crew on the Barge. At Left—Examining the Drills and Electro-Magnets. Top Right—Going "Over the Top." Lower Right-Hand View—Lights On and Going Down.

ELECTRICAL RESISTANCES AT LOW TEMPERATURES

By Harry E. Dey, E. E.

The resistance of all pure metals to the flow of electricity decreases in proportion with the temperature, until at the absolute zero, (minus 273 Centigrade) *there is no resistance.* If it were possible to extend wires to the space beyond our atmosphere, which is supposed to have a temperature of absolute zero, unlimited power could be transmitted from any one portion of the earth to the farthest point away on the filmiest of wires and without loss, excepting on that portion passing thru the air which is estimated to extend about 45 miles above the earth. From New York to the moon would waste much less power than is now lost between New York and Buffalo.

RECORD-BREAKING HIGH VOLTAGE POWER LINE.

The Big Creek system of the Southern California Edison Company transmitting electrical energy at 150,000 volts into Los Angeles, a distance of 275 miles, represents a world's record in power supply. This splendid system has two steel tower lines. It receives its energy thru single phase transformers weighing 81 tons—the largest yet built. Energy is generated from two power plants, one dropping the water 1,900 feet and the other 2,100 feet. The present installed capacity is 64,000 k.w. Ultimately the project is capable of a development of 225,000 k. w.

HE DUCKED THE LIGHTNING!!!

Olympia, Wash., is some speedy place—If you don't believe it read this!

"Lightning struck in the same place twice in 30 years when it destroyed the home of Mrs. D. G. Parker, on Eastside street," says a "special" dispatch to a local paper of that city.

"A neighbor climbing down an adjoining cherry tree *managed to duck the flash.* Fire followed that burned the Parker house. Mrs. Parker escaped without being stunned." Well! Well!

NEW MEXICO RADIO STATION

There has been establisht a new Mexican Wireless Station on the island of Lobos, off the coast of Tampico, erected mainly for the purpose of affording facilities to the various petroleum companies for communicating with their vessels over great distances at sea. This station is said to be provided with some of the most powerful apparatus available, and is expected to establish communication with the Wireless Stations at Mexico City, Tuxpan, Tampico, Vera Cruz, Progresso, Frontera, Mazatlan, Santa Rosalia, La Paz. Queretaro, Monterrey, Saltillo, Torreon, and by way of Havana with various stations in the United States.

With wireless stations powerful enough to reach vessels in all of its waters, the Chinese government will establish a typhoon warning service.

Electricity and Radio as Used by "Movie" Spies

By GEORGE HOLMES

THE motion picture dramas seem to be filled with scientific features now-a-days, especially in connection with German spy plots. To begin with we have the big patriotic film serial "The Eagle's Eye," from which we show photos of three episodes. The first is the adventure of "The Brown Portfolio." The greatest single discovery which has been made in connection with the investigation of the Imperial German Government's spies and plots in America, came thru the persistence with which operatives of the United States Secret Service kept on the assignment of watching Dr. Heinrich Albert. Day after day, and night after night, they followed him thru a daily routine which seldom varied. They took nothing for granted and the result was that one afternoon, Dr. Albert became drowsy when taking his daily trip from his office to the German Club. His doze cost him the possession of a brown portfolio, the contents of which was the first verification of suspicions that had long been held by Chief William J. Flynn, of the Secret Service, that the Imperial German Government, itself, was backing the Hun propaganda in America.

Chief Flynn became curious about the contents of a brown portfolio which Dr. Albert always carried and assigned operatives to shadow him. At the time the United States and Germany were maintaining friendly relations, sincere on the part of the Washington Government, but absolutely hypocritical as far as the Kaiser's representatives were concerned.

So the operatives assigned to Dr. Albert merely watched him, noted his visitors and his daily routine. Everywhere he went there was an indistinguishable shadow always with him. Dr. Albert lost his portfolio because he was aroused from a doze by hearing his station called by a guard on the elevated train on which he was a passenger. He forgot the bag for a moment, and his "shadow" got possession of it.

"Doctor, if thru your carelessness those papers have fallen into the hands of the Secret Service," the German Ambassador exclaimed, "then steps will have been taken to warn the ships which are already upon the ocean, on which bombs have been placed. Arrange to have wireless warnings intercepted."

The Ambassador walked from the room to his own private suite. Dr. Albert seized the telephone, almost distraught. He called Captain Boy-Ed. A second call appraised Captain von Papen of the disaster. A third telephone number and Heinrich von Lertz had been summoned to do the bidding of the arch spy—the accredited Ambassador of the infamous Imperial German Government.

And listening in on the wire which had carried the summons to Heinrich von Lertz was—

Miss Dixie Mason of the Secret Service.

That explains why that just at the moment when the Hun spies had started to raise the aerials on the wireless mounted on an automobile on a lonely road in Long Island, that a high powered automobile loaded with Secret Service operatives should appear. The agents of the Kaiser fled, but their automobile proved unfaithful and a skid in rounding a corner wrecked the machine against a bridge (see Fig 1).

Next we have the big "Munitions Scandal." French soldiers on the first line in France were saved from a merciless assault from mast German troops at a time when the French artillery would have been useless, by the alertness of the U. S. Secret Service. Members of the Kaiser's spy army in America had successfully started on a plan which would have made a large shipment of artillery shells of every calibre for the French artillery useless because it would have been of a size which would fit only German guns. The specifications for the manufacture of the shells had been changed, when a trivial matter of the name of the ring-leader in the plot

(*Continued on page* 356)

Fig. 1.—Von Papen's Traveling Auto Wireless Meets with Disaster On Long Island and Wolf Von Igel Is Seriously Wounded. Fig. 2.—Harrison Grant, President of the Criminology Club and Head of the Secret Service Discovers Dixie Mason at the Power Plant Switchboard with Her Arm Caught in the Switch and Herself In a Dead Faint. Fig. 3.—Dixie Mason Is Surprised at the Wireless Room of the U-53. Fig. 4.—Guy Empey's "Over the Top"—The German Count and His Accomplice, at the Switchboard of a Tall Office Building Somewhere In Downtown New York, Ready to Throw the Switch at Midnight Which Will Light a Signal on Top of the Tower, Thus Notifying the Other Spies on the Jersey Shore That It Is Time to Begin Blowing Up Munition Factories and Ships.

Lassoing Aeroplanes with Bomb and Flame

By H. GERNSBACK

STOPPING an aerial raid by means of anti-aircraft guns is a notoriously impossible undertaking. While the aeroplane itself is now, and probably will always be the most trustworthy means of combating enemy bombing planes, there has been felt for some time the want of other means to bring down the raider.

We must not lose sight of the fact that a large city like Paris or London requires hundreds of the very best fliers as well as machines to safeguard these cities. These fliers could be used to a tremendously better purpose at the front hunting down Hun planes, while the former are kept locked up indefinitely to ward off enemy bombing squadrons.

Anti-aircraft guns firing shrapnel do not bother an intrepid flier in the least nowadays. It frequently happens that a pilot must fly as low as 2,000 feet in order to successfully set into flames a boche "Drachen," as the German observation balloons are called "Over There." These aerial sausages are fired upon at close range by the Allied pilots, who use incendiary "phosphoric" bullets to accomplish the purpose. To do so they must fly low which immediately draws the fire of the boche protecting anti-aircraft guns below.

Nevertheless our pilots brave his barrage and fly right thru it. They "slip," nose-spin, loop-the-loop or "pancake," making it almost impossible for the gunners to get the range. If the pilot knows his business he returns invariably to his airdrome, barring a few holes in his wings or in the fuselage of his machine. For be it known, there is no greater disgrace for a flier than to be shot down by land guns.

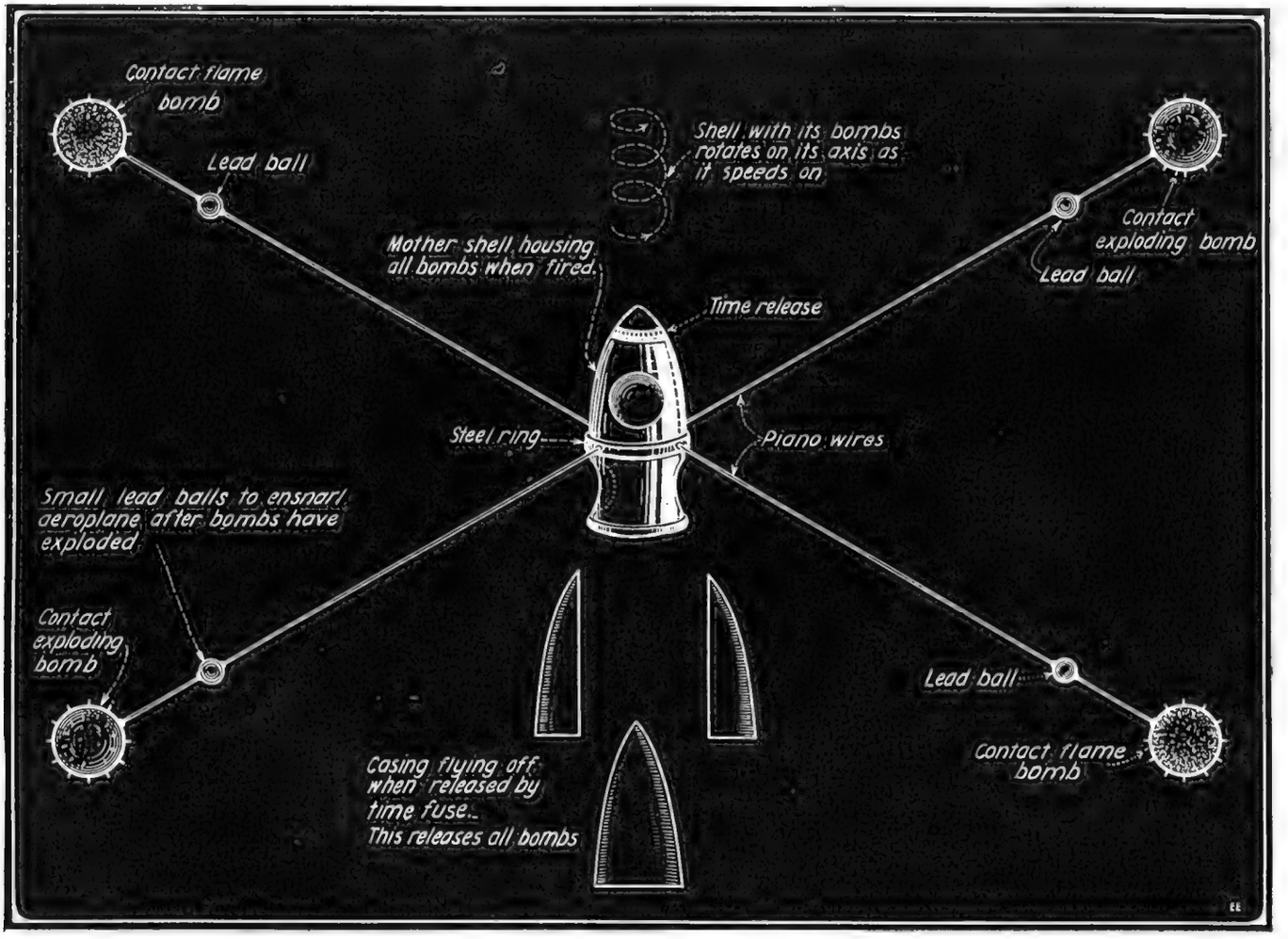
If we had a positive means to bring down a raiding flying machine without utilizing our own or our Allies' aeroplanes, we would, of course, have the enemy at a great disadvantage.

Bearing these things in mind, the writer advances a plan which to a certain degree accomplishes such a result. The principle itself is very old and well known, the application and the various refinements only being new.

In short the idea centers itself upon the time-worn "chain-shot," which was nothing else but chaining several cannon balls together and shooting them at the enemy with devastating results. As the erratic flight of such a device made it extremely inefficient, it was soon given up and came into disuse.

In the present device the writer proposes the use of a "mother-shell" containing two explosive bombs, as well as two "liquid-fire" bombs. Each one of these bombs has a smaller companion—a heavy lead ball, the purpose of which is explained later.

All of the bombs and balls are normally housed in the metal mother-shell which need not be very heavy, as it does not contain any explosive charge itself. All the bombs are kept in their respective places by means of a casing composed of eight pieces of reasonably thin steel. These pieces are released from the mother-shell, and fly off as soon as the time mechanism located at the apex of the mother-shell permits this. This time mechanism works on the principle of the one used on shrapnel, the purpose of the present device being to keep the mother-shell intact till it comes within a few hundred feet of the aeroplane under attack. This, of course, makes for great accuracy, as the mother-shell can be accurately timed, and being a self-contained shell like any other, its flight will naturally be true.


Contact flame bomb
Lead ball
Shell with its bombs rotates on its axis as it speeds on
Contact exploding bomb
Lead ball
Mother shell housing all bombs when fired.
Time release
Steel ring
Piano wires
Small lead balls to ensnarl aeroplane after bombs have exploded
Contact exploding bomb
Lead ball
Contact flame bomb
Casing flying off when released by time fuse. This releases all bombs

A new "Lasso Shell" which can be shot from a cannon and used to combat enemy aeroplane attacks. It is fitted with a time fuse so as to "explode" at a certain height, liberating the explosive and flame bombs, attached by piano wires as illustrated. If these do not finish the enemy 'plane there are still the flying lead balls to be conjured with.

The mother-shell in addition is "rifled," exactly like other big shells. A rifled shell while still in the cannon is made to turn on its axis by following a corkscrew path cut into the inner walls of the cannon. This imparts a spinning action to the shell which it maintains during its entire flight. So while the shell flies over its course with its nose pointed at its target, *it also spins like a top.* This spinning action, it has been found, keeps the shell better on its course than if it did not spin.

In the case of the rifled mother-shell, another distinct advantage is had. Aside from keeping the shell on a true course as soon as the time mechanism acts, the pieces of the casing are thrown violently outward by centrifugal action. The same is the case of the four bombs which are hurled outwardly as shown in our cover illustration. Each set of bombs and balls are attached to a central steel ring by means of a thin, but tremendously strong steel piano wire. Each wire may be from two hundred to three hundred feet long as desired. But as the mother-shell and the various bombs still have their rotary (spinning) motion, it follows that the entire device will continue to revolve not unlike a miniature planetary system. The four piano wires will be straight and taut, and as they cut the air at a great rate of speed, they will probably "sing" with a weird as well as a shrill note. If you ever swung a stone attached to a string over your head, you will know what we mean.

We now have an aerial lasso *par excellence,* covering a circular space of from four hundred to six hundred feet, all depending upon the length of the piano wires.

Woe to the enemy aeroplane flying into it, or which is overtaken by it! There can be no escape. If either of the two contact-exploding bombs touch the aeroplane, it will be wrecked by the terrific ensuing explosion. If either of the contact-flame bombs touch, liquid fire will be sprayed over wings or fuselage, setting the plane on fire.

But let us suppose that neither type of bomb were effective, or touched only non-vital parts of the enemy plane. Here it is where the lead balls take up their deadly work. Suppose all the four bombs had been exploded. If it were not for the four lead balls, the four piano wires would simply go limp and the fight would be over. But having these lead balls spaced about ten feet from the explosive bombs, they will not be affected at all after the former have been set of. The planetary system broadly speaking, still remains intact, altho now we have only four "moons" left. But suppose only one of them manages to get entangled in the trusswork of the enemy plane. Immediately the flight of the entire system is stopt abruptly and the three other balls come whizzing around, snarling up the entire plane and breaking the wings, fuselage or tail as they come crashing down at a terrific speed. You have read of the terrible Mexican lasso, the *Bolas,* which is a lasso with lead balls. It works on the same principle as our aerial lasso, only the latter having lead balls weighing several pounds apiece, will cause correspondingly greater havoc, especially on a comparatively fragile aeroplane.

Perhaps you have read accounts of aerial fliers and their dread to intercept the course of even the smallest bird. It is a well known fact that an aeroplane propeller revolving at its great speed, will be instantly shattered if a bird as small as a sparrow flies into it. Therefore it may be imagined what a large lead ball, or a powerful piano wire will do to a propeller, should either come in contact with it.

To prevent the aerial lasso from causing widespread damage thru fire or explosion, should it miss an aeroplane, the four bombs can be equipt with time fuses, exploding them before they reach the earth. Of course, the four lead balls might cause damage, but certainly not more than the myriad of shrapnel balls and shell fragments, crashing to the ground during an aerial barrage.

The aerial lasso built on a smaller scale could, of course, be used between combating aeroplanes. If our planes were equipt with them, as well as the necessary guns to fire them, the Boche planes certainly would be at a terrible disadvantage.

NOTICE

With the September issue nearly every magazine which heretofore sold for 15c goes to 20c. This includes every prominent scientific and technical magazine. The price of the *"Electrical Experimenter"* for the present remains at

15c

Altho tremendous pressure is being exerted upon us from all sides, due to soaring prices, we will not raise the price of this magazine at present. Paper alone has advanced from 4c per pound three years ago, to 11c a pound now, with printing, postage, engravings, art work and labor increased proportionally.

No other scientific Journal gives as much for 15c as the *"Experimenter."* All other magazines in this class print their pages in ten point type. Ours is printed in eight point type:

This is *ten* point type.

This is *eight* point type.

Note the difference. *"Experimenter"* pages contain 30 per cent more matter, space for space, than the other magazines. Your 15c spent on this Journal really buys more than two 20c magazines. And we believe the quality of our matter is much above the average. Won't you show your friend this copy, or tell him about it?

—*The Publishers.*

WHAT IS HIGH SPEED?

One of the first questions the layman asks the aviator is, "How does it feel to fly?" by which is generally meant, what is the sensation of speeding thru the air at the rate made possible by the aeroplane. The following abstract from an article appearing in *Flight* should be enlightening:

An analysis of sensation is always interesting and might be expected to be exceptionally so in the case of speed, yet paradoxically enough there is no such thing as a sensation of speed. There are many proofs of this, but I will adduce for one, that the early centuries of human existence man, tho he has since been proved to be moving thru space at the prodigious speed of some thousands of miles per hour, thought himself to be living on the immobile hub of a rotating dome of the moving planets and stars.

What then is it that we feel when we are moved rapidly by an aeroplane? The answer is the illusion of speed, inspired by a summation of sensations which we have the habit of associating with rapid motion. This illusion can easily be induced without moving the man, and it has often been done, for example, at one of the Earl's Court exhibitions a passenger trolley on a few feet of rails was arranged at the centre of a large room of which the walls and ceilings were mounted so as to be bodily rotated round the trolley. The trolley was given a little jerk to convey the impression of a starting acceleration, and then as the trolley became *stationary* the room was made to turn at an increasing speed round the experimenters, who suffered from the conviction that they were traveling on smooth rails at a high speed.

Our impression of speed is derived largely from the optical effect, due to adjacent objects flitting by, and is increased by a surface or skin effect due to the wind which brushes past us and cools and presses on to our persons. These two effects are sufficient, but the impression is heightened by going a little further. Our past experience of most mechanical and animal means by which we have borrowed speed has shown us that they are rarely if ever perfectly smooth in their action. After the change of speed due to the starting operation there are slight irregular changes of speed and changes in the direction of the movement. These are always associated with rapid traveling; we call them jolts and jars if they are severe, and we wrongly regard them as part of the sensation of speed, tho they are pure accidentals. They ought properly to be called accelerations, and the act of starting is the only acceleration which is in fact necessary to obtain speed. Yet a fourth factor can be detected in many of our impressions of speed. I allude to noise, whether of whistling wind or of beating hoofs or of moving machinery. These things no more constitute a sensation of speed than the bristles constitute a hedgehog. They are merely excrescences and causes of independent sensation. At one time or another an aeroplane flight gives rise to all these sensations to an acute degree, and super-adds one novelty, that of the point of view.

The following comparative table of speed is of interest:

1. Light and the electric telegraph, 186,000 m.p.s.
2. Shell near the muzzle of 6-in. gun, 2,500 feet per second.
3. Shell from 75 mm. gun, 1,600 f.p.s.
4. Sound, 1,100 f.p.s.
5. Revolver bullet near the muzzle, 500-800 f.p.s.
6. Tip of the blade of an airscrew, 600 f.p.s., or 400 m.p.h.
7. A fast aeroplane through the air, 150 m.p.h.
8. A fast aeroplane with a high wind, 200 m.p.h.
9. A fast car, 120 m.p.h.
10. An express train, 80 m.p.h.
11. A fast steamship, 40 m.p.h.
12. A bicycle (pedaled), 32 m.p.h.
13. A race horse, 30 m.p.h.
14. A man skating (for a mile), 24 m.p.h.
15. A man running (100 yards), 20 m.p.h.
16. A man running a mile, 13 m.p.h.
17. A man walking, 4 m.p.h.

French electrical works have arranged to employ men who have been blinded in the war to wind armatures after the system of Dr. Schuyler Wheeler of New York. It is also understood the system will be introduced in England.

AMONG the hundreds of new devices and appliances publisht monthly in the Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

New Electrical Ideas on Submarines and Torpedoes

THE busy war inventors have been bombarding the Patent Office at Washington with hundreds and even thousands of more or less ingenious ideas on improvements in submarine warfare. Some of the latest endeavors of Yankee inventors in this branch of naval science are here illustrated and described.

The first idea represents what its inventor —August S. Trautman—prefers to call "a submarine safety and observation device." His invention purports to provide a combined life-saving and observation chamber which is normally housed within a suitable compartment on board the submarine. When the submarine happens to become disabled thru a naval engagement or otherwise, or in the event that the commanding officer should want to ascertain whether any enemy war vessels were in the immediate neighborhood before rising to the surface, it then becomes possible to have an observation officer enter the buoy chamber shown, thru suitable water-tight doors; when the buoy chamber is opened to the water the buoy then rises to the surface.

The buoy is at all times under control by the submarine by means of a steel cable attached at one end to the bottom of the buoyant chamber and at the other end to a motor-driven windlass on board the submarine. A telephone and electric light cable is also unreeled with the buoy as it rises to the surface, so that the observation officer can at all times communicate directly with the submarine commander below.

As the inventor points out, his device can be made large enough to hold several men instead of but one, for the purpose of saving the crew's lives, and it is not at all difficult to arrange the apparatus so that the life-saving buoy could be hauled down to the submarine several times in order to remove all of the crew in case of disaster. The buoy could be designed sufficiently strong and provided with a sufficient length of cable to enable it to rise thru a depth of water of two hundred to three hundred feet.

As the illustration shows, the observation buoy is fitted with telephone and electric light as well as one or more rapid firing guns, photograph apparatus, binoculars, etc. The floating compartment is provided with suitable gyroscopic apparatus driven by an electric motor for the purpose of stabilizing it, and there is also provided a means whereby the center of gravity of the buoy can be changed by shifting a weight whenever the gyroscope might prove inactive. There is furthermore a propelling mechanism driven by a motor and so designed as to cause the buoy with its occupant to be propelled in a body of water and beneath the surface thereof, and to be guided according to the desires of the operator. The cover of the buoy may be camouflaged so as not to become readily detected by the enemy.

An oxygen tank is fitted within the buoy for the purpose of supplying the observer with oxygen during the time that he is confined therein, and also a reserve tank is provided in the container whereby air from the outside may be collected and accumulated. A motor-driven pump is provided to operate the auxiliary air apparatus. The buoy can be made to describe a circular path by means of a suitable rudder provided at the base of the structure.

The second idea here illustrated is that of an electrically operated *Dirigible Torpedo,* its inventor being James M. Seymour, Jr. Mr. Seymour provides considerable food for thought in his novel invention which comprises a cigar-shaped steel hull, the interior of which is subdivided into a number of separate chambers, each one of which is adapted to house the various electrical and other apparatus necessary for controlling the torpedo. This steel hull is normally submerged beneath the surface of the water, and supported at this depth by means of a surface float which carries visible identifying means, such as colored flags or disks in the day time, and signal lights flashed intermittently at night.

In brief, Mr. Seymour's electrically controlled dirigible torpedo is of the self-propelled type, being provided with a special internal combustion engine adapted to run on a fuel consisting of hydrogen and oxygen. The engine is provided with an electric self-starter, and the motor for this apparatus may operate when the torpedo is under way as a dynamo, supplying current for charging storage batteries, etc. Fuel for operating the engine is contained in a suitable storage tank in the torpedo hull, and also the supply of gases ready for mixture to produce the fuel for the engine.

This dirigible torpedo is intended to be controlled thru a fine electric cable connecting it with a war vessel operating in the vicinity. The cable being of small size is stored in the hull of the torpedo, and is wound in an ingenious manner so as to be released rapidly and easily and without danger of knotting. The inventor's design enables a very small insulated electric cable to be used for this purpose (with its consequent high electrical resistance) for the reason that he uses a sensitive galvanometer relay, which can be actuated by relatively weak electric currents coming thru the cable. The front end of the torpedo hull contains the high explosive gun-cotton or other charge, which can be detonated at any desired moment by simply pressing a button on the torpedo boat destroyer or other vessel controlling the torpedo. It may be a surprise to the reader to learn that this small yet destructive war device may have a field of action as great as ten to twenty miles, this being the radius over which the torpedo can be sent, and a sufficient length of patrol cable carried therein for the purpose, the inventor claims. When the torpedo is placed over the side of the war vessel, the engine self-starter motor is set in motion by means of a pull cable running up to the top float and fastened to a button thereon.

The third electrical idea is an interesting *Cable-Cutting Shears,* intended to be mounted on the bow of a submarine or similar vessel. As is well known, it is a slow job for mine-sweepers to trawl along thru considerable areas, feeling their way and cutting loose the submerged but firmly anchored mines. The contrivance here suggested by Mr. Johan E. Johannessen would seem to offer some worthwhile ideas in this direction. His electrically operated mine-cable shears are intended to be secured to the bow of a submarine, and also the vessel so fitted with this device is provided with a suitable observation port or window and an adjustable and fairly powerful electric searchlight as in the illustration. In this way the submarine can make considerable speed in cutting the submerged mine-cables, and the shears are provided with large horn-shaped guides which serve to force the cables toward the cutting blades of the shears. When in action these steel blades are rapidly oscillated in the same manner as a pair of scissors, by means of an electric motor located within the submarine. The motor is connected to a shaft attached to the cam actuating the shear blades thru a water-tight stuffing box.

As the mine cables are cut and the mines float to the surface, they can be picked up by any vessel adapted for the purpose, and working in conjunction with the submarine or submarines. The operation is best carried out at night of course. The ends of the cable shear guide-horns are provided with electric lights to enable the operator to guide his boat more quickly in the proper direction to encircle the cable and cut it.

The operator is provided with loud speaking telephone equipment, signal lamps, etc., as well as electric controller for the shear motor, so that he has very accurate control of the apparatus, and also the movements of the underwater craft. He can thus instantly give orders to the helmsman to change the direction of the submarine, etc. The cable-cutting shears are designed by the inventor, so that they can be readily bolted to the bow of the submarine and quickly removed as soon as the cable-cutting operations are completed.

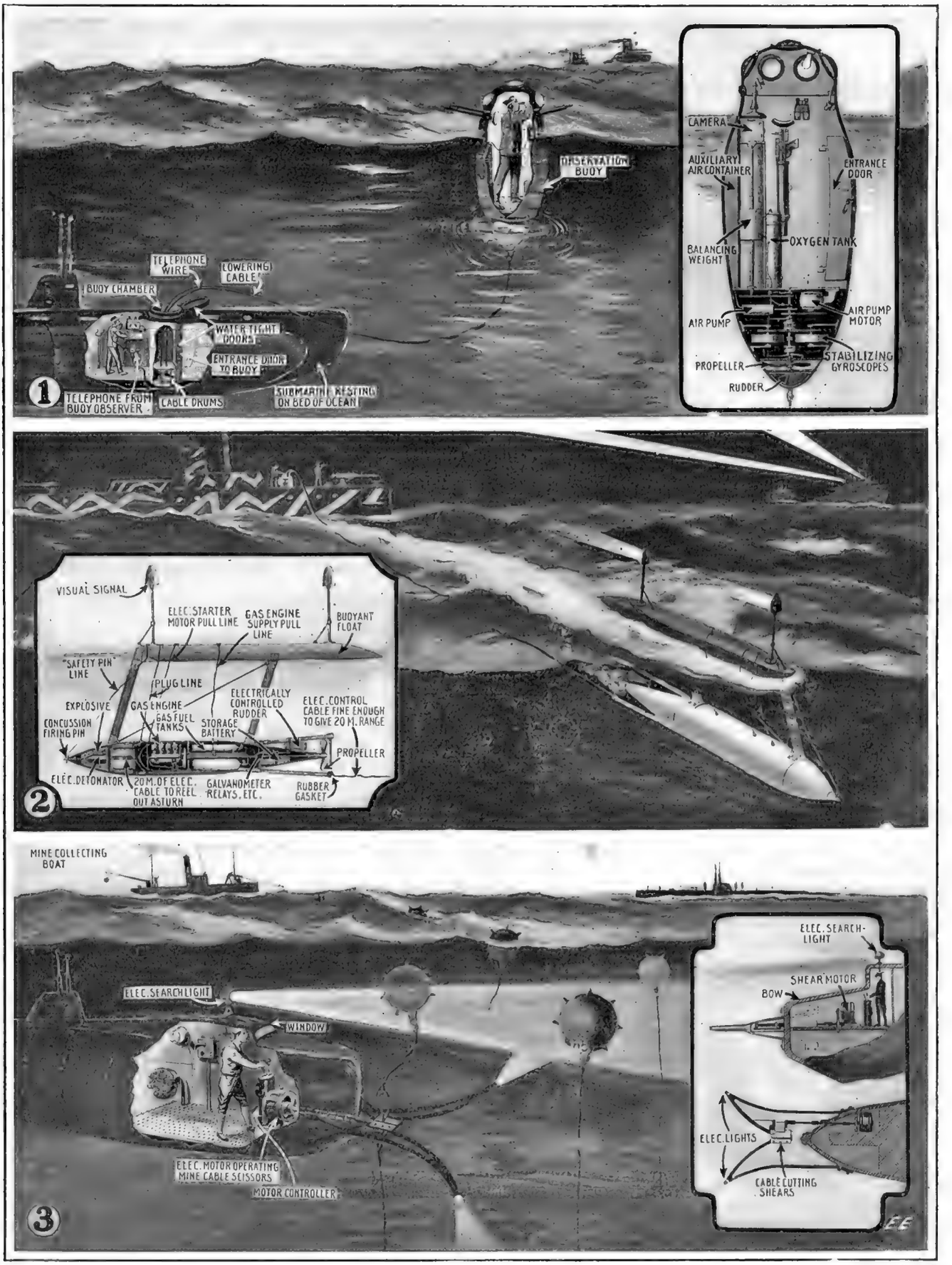
WHY THE ELECTRIC GUN WILL NEVER BE A SUCCESS.

By Harry A. Dey, E. E.

Every few years a new inventor springs upon the public our old acquaintance, the electric gun, which has so many good talking points. An electrical engineer of our acquaintance, was one of the inventors. He did not, however, place it before the public. He went ahead and spent a few of his own dollars, and soon became convinced of its impracticability. This was nearly thirty years ago when the dynamite gun ship VESUVIUS was first constructed. Our electrical friend got to thinking how nicely electricity, by means of a long solenoid barrel, could throw that charge of dynamite without danger of the shock blowing up the gun. He made some experiments, actually building one of one inch bore, and followed this up by experimenting with the pulling power of solenoids. If the solenoid experiments had been made first, the gun would not have been built; for he found that 25 pounds per square inch was about the best pull that he could expect, and the VESUVIUS required 600 pounds per square inch to toss its bomb a mile or two over the hills. He threw up his hands in disgust at himself for not beginning his experiments at the other end of the line. If he had started out by investigating the power required on the VESUVIUS he would have gone no further, for he well knew that this was from 3 to 4 times as much as an electro-magnet would pull when in actual contact, which is impossible in any moving device; the pulling power dropping very rapidly upon the insertion of any air gap. The best that could be expected from any gun of this type, even if made of an impractical length, would be to use as a substitute for hand throwing of bombs from trench to trench when they are within a female baseball pitcher's range.

An electric magnet weighing only seven pounds that will lift fifteen times its own weight has recently been invented. It is intended for use in machine shops.

NEW ELECTRICAL IDEAS ON SUBMARINES AND TORPEDOES



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(For full description see opposite page)

Popular Demonstration of Thought-Transference and Other Phenomena

By ALBERT ABRAMS, A. M., M. D., LL. D.

Professor, Cooper Medical College (Medical Dept., Stanford University, 1893—1898.)

DETAILED reference to this subject-matter may be found in my book, "NEW CONCEPTS IN DIAGNOSIS AND TREATMENT" where attention was first directed to the demonstration of these phenomena by apparatus not available to the laity. Telepathy is in disrepute and the scientifically minded psychologist doesn't believe it. Science demands that phenomena should be objective, capable of reproduction at all times and demonstrable by instruments of precision.

Fig. 2. Once You Have the Straw "Detector" Rigged Up on the "Percipient's" Wrist, Then the Shadow or Even the Movement of the Straw Itself Can Now Be Watched Closely In Front of a Square-Ruled Paper. This Is Your "Thought Wave" Detector and Indicator.

The simple scientific method which I shall present shows that spiritistic phenomena are independent of disembodied spirits and referable to human energy: that it will serve as a means of disocculting the occult and will enlist the genius of the multitude in corroborating my original investigations.

We anticipate that this article will create a sensation in scientific circles, as well as with laymen, and we present it for what it is worth. We have not made any of Dr. Abrams' tests, and we print the article with an open mind—neither endorsing nor condemning it. We say with Shakespeare: "THERE ARE MORE THINGS IN HEAVEN AND EARTH, HORATIO, THAN ARE DREAMT OF IN YOUR PHILOSOPHY."

Dr. Abrams is well known as a scientist; he has made this interesting subject his life work, and his views are endorsed by many prominent doctors and scientists. He is the author of numerous works, amongst them an elaborate book:—"New Concepts in Diagnosis and Treatment."

Will our readers please advise us should they be successful with Dr. Abrams' experiments?—The Editors.

Fig. 4. On Either Side of the Wind-Pipe In the Neck, As the Two Black Marks Show, There Are Located the Right and Left Pneumogastric Nerves. When These Nerves Are Stimulated, the Needle Movements Show Less Amplitude; and When They Are Depressed the Movements Are Greater.

TELEPATHY.—Derived from tele, at a distance and *pathos*, feeling, it signifies that one mind (*agent*) can influence another mind (*percipient*) without the agency of the recognized organs of sense.

BRAIN-WAVES are an actuality and like light and the impulses of "wireless" are conveyed by the ether.

The ELECTRON THEORY shows that the ultimate constituents of matter are *electrons* or charges of electricity and that RADIO-ACTIVITY is dependent on ethereal disturbances by a change in motions of the electrons.

ANIMAL REFLEXES.—When the pupil of the eye contracts to light it is a REFLEX and involuntary. The reflexes surpass in sensitivity any instrument devised by science and show that RADIATION is a universal property of matter. The perceptive structure of the eye (Retina) is 3,000 times as sensitive as the most rapid photographic plate and the nerve of vision (optic), 2/5 of an inch in diameter contains 500,000 to 800,000 insulated fibers.

The electro-magnetic waves in "wireless" demand an exciter, but the sensitive human reflexes first utilized by the writer in detecting energy make an exciter unnecessary: the revolutions of the electrons *alone* substitute the exciter.

THE HEART.—The writer employs this muscular organ among other reflexes for converting energy waves into a sensible form.

It is coincidently a receiving station and also a detector of etheric thought waves.

TECHNIQUE.—The percipient must have a regular and comparatively large pulse and must be seated in a comfortable chair facing the geographical West. Colored wearing apparel must be avoided by agent and percipient: the latter's eyes must be closed to avoid distraction, breathing regular and mind abstracted during all observations. Experiments should be executed primarily in daylight. All reference to the *pulse*, refers to the movements of the straw connected to the percipient's pulse. Find the latter (Fig. 1) and indicate its location with a pencil.

Cut a very small piece of adhesive plaster and roll it so that the roll presents an adhesive surface on both sides.

Fig. 1.—X indicates the site of the wrist-pulse.

Fix it parallel to the pulse. To the plaster attach one end of a very fine straw (from a broom), 6½ inches long. Place the straw at an angle so that it will approximate a sheet of ruled paper (vertical lines).

Fig. 2.—Position of arm with straw attached to the pulse.

Observe the swing of the straw directly or as a shadow. In the latter event, if the light is from the South use the right and if from the North, the left pulse.

Note that the greatest amplitude of the straw is secured by the arm resting comfortably on a book or cushion with the hand dependent from the side of the table (Fig. 2).

EXPERIMENT I.—*Solving the mystery of mind acting upon mind by brain waves traversing the ether.*

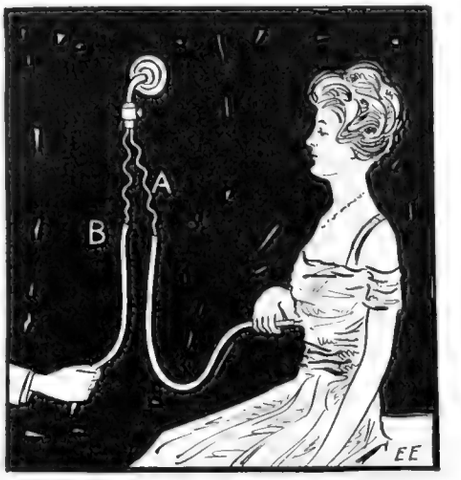


Fig. 3. Arrangement of "Percipient" to Show the Electrical Effect Created By Concentration of Mind By the "Agent," Even Tho He (or She) Be Situated Forty Miles Away. A Wire Connects the "Percipient" With the House Electrolier.

Prove that the brain wave-theory is correct despite the fact that, telepathic effects unlike other forms of radiant energy do not vary in intensity according to distance. The moment a person (agent) WILLS FORCIBLY (not mere thought) there is a slight hesitancy or retardation of the straw. Close observation shows a slight extra kick of the latter followed by a transitory stop (inhibition). Each time the agent wills in the direction of the percipient (irrespective of distance), the pulse effects may be noted. Before each act of willing by the agent, at least 10 seconds must elapse to permit the percipient's heart to recover from the excited reflex. The latter is easily exhausted by too much experimentation on the same subject. If several persons are present, their minds should be passive so that the waves from the agent alone will act. Note by the effects on the pulse that some are able to will more forcibly than others.

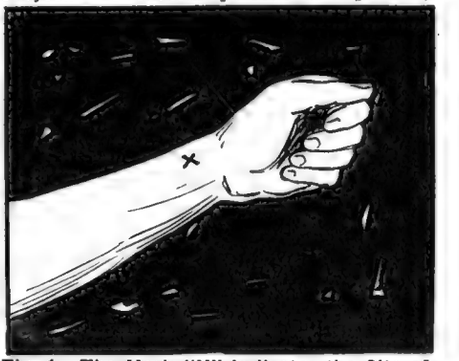


Fig. 1. The Mark "X" Indicates the Site of the Maximum Wrist Pulse, and At This Point Dr. Abrams Affixes a Small Piece of Adhesive Plaster, and One End of a Very Fine Straw.

(*Continued on page* 345)

"Over There"—A Miniature War Panorama

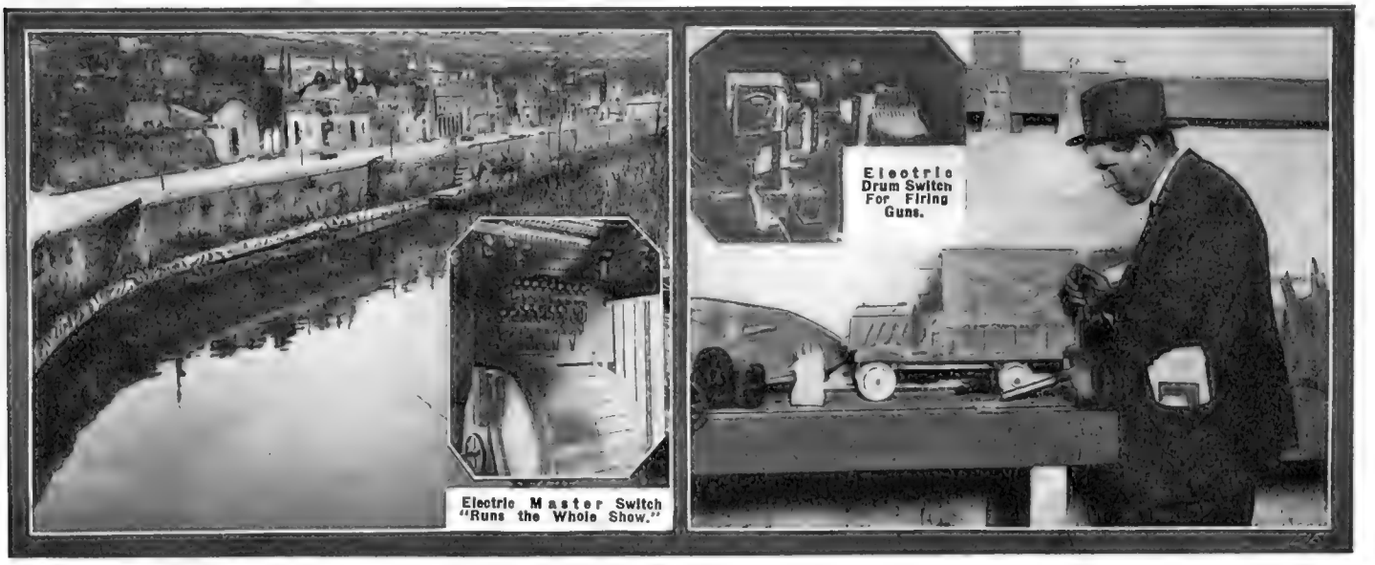
By GEORGE HOLMES

REALISTIC and beautiful is the presentation of a great Spectacle or Panorama in the miniature, when correctly staged. This field presents a wonderful opportunity for the real genius and creative mind to bring forth truly enchanting effects of color, scene and action. A splendid example of this fascinating art may be witnest in the new and timely panorama "Over There" now being presented at "Luna Park"—the far-famed heart of Coney Island, New York City's pleasure ground. To say that Luna is presenting it spells its success and from all accounts it bids fair to equal in fame if not exceed the original battle panorama of "The Battle of Waterloo," done by Robert Barker, or our own "Battle of Gettysburg." The creator of "Over There" is Mr. Hugh Thomas, for years associated with the big Coney amusement resort, projector of the "Submarine Battle," and other mammoth indoor spectacles.

There is a value about the panorama which cannot be denied. First of all, it lends itself only to subjects which are informative and therefore educational. No matter what the impelling idea of the author, whether purely for commercial amusement purposes or not, he eventually proceeds to inform and spread knowledge.

To many, the fact that the panorama has a serious history away from its uses as an amusement proposition will come as news. Yet its initiation is connected with no less a personage than Sir Joshua Reynolds. The invention, for it was originally patented as such, came from the brain

(*Continued on page* 353)

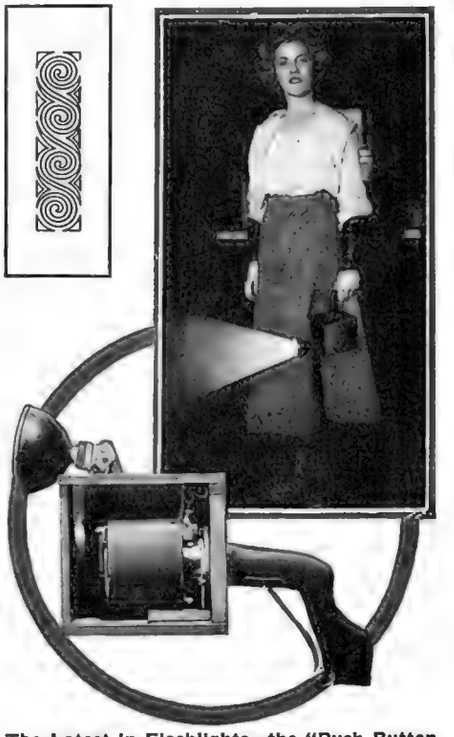


"Out Front" and "Behind the Scenes" of Coney Island's Latest Success—"Over There"—a Complete Living Picture In Miniature of the European Battle-Fields. It Took a Real Genius To Produce the Thousand and One Details So That the Audience Could See What "Shell-Fire" Does to a Peaceful Little French Village.

PUSH BUTTON—DYNAMO SPINS—LAMP LIGHTS!

Flashlights are now used by the million all over the world—practically every well equipt soldier in the Allied as well as in the German armies, not to mention the navies, carries an electric flashlight. Think what it would mean if overnight a modern Aladdin should wave his magic wand and decree that the flashlight could stay but that the batteries must go. Such will be the magical change which will overtake us one of these fine days when the invention illustrated herewith is successfully exploited and made cheap enough to be available to every man, woman and child who have any use for flashlights.

The model of the push-button dynamo flashlight shown herewith is somewhat large as it is the first model constructed by its inventor. The principles on which it is designed are, however, correct, and it is only a matter of refining the details of its make-up in order to reduce its size and weight. As herewith illustrated, the trigger which is placed on the handle and resembling that of a revolver, is successively pulled toward the handle by a natural gripping action of the hand, and this trigger works a quick-acting worm or screw similar to that found on the well-known ratchet screw-driver. The other end of this trigger actuated ratchet is mechanically connected with a small alternating current dynamo or magneto, which supplies the necessary current to light the flashlight bulb. The bulb is mounted in the usual reflector and furnished with a suitable lens.



The Latest In Flashlights—the "Push Button Dynamo Light." A Small Dynamo Does the Trick.

Several years ago a similar dynamo flashlight intended to be operated by the pressure of the hand or fingers was brought out in Europe, but due to the war conditions which followed soon after its introduction, it has never reached the United States. The type of dynamo flashlight here illustrated was invented by a Yankee genius and the model was thoroly demonstrated before the editors.

WONDERS NEVER CEASE

"The Office Dog" conducts a full page feature in the amiable *Ladies' Home Companion.* It is usually a very bright page and you can learn a lot from it. We like it. Dogs, however, are notoriously shy of electricity, as any boy who has a spark coil AND a dog will readily testify. Dogs and electricity never mix. "The Office Dog" is no exception to that rule. He is shy on electricity too! Witness the following blossom plucked from its May, 1918, page:

> Walking in a thunder storm under an umbrella with the modern metal rod is now said to be about the most dangerous of practices, since the metal is an *almost* certain conductor of electricity.

The italics are ours. It was a new discovery to us, that a metal could be an *almost* certain conductor. Will the "Office Dog" please send us at once a sample of that remarkable metal for analysis? Will gladly send him in return an *almost* certain soup-bone, guaranteed to give *almost* certain food for thought!

The Man Who Stayed at Home

At last! A war play without "fire-works." To say the least, our American audiences have been bombarded with a class of productions and films that tended more to the "flag-waving" and "patriotic airs" variety, than to any real semblance of plot, story or genuine interest; which would in a moderate way serve to amuse, thrill and most of all, go a long way in the moulding of opinion and stir one to real conscientious and patriotic thought.

A Critical Moment from the Timely Play "The Man Who Stayed At Home." The Photo Shows Mr. Brown and Miss Kaelred in the Act of Intercepting a Submarine Message and Falsifying a Reply That Led the German U-Boat Astray and to Capture by the British Sea-Dogs.

The production in mind was presented originally under the title of "The White Feather," by Mr. William A. Brady, at the Comedy Theatre in February, 1915. This was of course before we Americans had begun to think of a war with Germany or the intrigues that were taking place daily right in our very midst. Naturally under such circumstances, the most part of us, self-centered, failed to see the moral in the piece and like many other unfortunate plays it was relegated to the storehouse.

The story of the piece has had some material changes made in it, in that now it is the American troops and their transports which must be protected from the under-sea sniper the "Hun Submarine."

The action takes place in an English coast town. Mrs. Sanderson and her son are running a boarding house as a blind, being actively engaged in spying for the Imperial German Government. Christopher Brent, an Englishman of dense or "Silly-Ass" type, is a boarder. Everyone upbraids him for being a slacker; even his best girl is doubtful of him. Naturally he feels very hurt but can offer no defense on his behalf for his seeming idleness because —S-S-S-H, he is a spy in the employ of the British Government! With him at the same house is his "cryptic" and beautiful female aid in the person of Miss Miriam Lee. His being so much with the aforesaid personage raises rebellion in the heart of his sweetheart, which further adds to all the troubles.

Nevertheless, and in a truly melodramatic style, he discovers the Hun's secret wireless outfit in the fireplace and turns it to his own advantage and then wrecks it. Further thrills are experienced in the attempted burning of the house and his almost untimely end in which he puts one over on the Kaiser's spies and their final round-up. Whereupon he wins his "lady-fair" and the glory of the whole household, even to Dad's profuse blessings!

U. S. X-RAY STATION ON WHEELS.

For operating between the field hospitals and the firing lines, a Chicago electrical genius, Mr. C. L. Fits, has developed the complete X-ray equipment illustrated. It is mounted on an automobile and derives its power from a specially designed direct current generator, driven by the engine. This generator is equipt to deliver 2 K. W. alternating current.

The transformer will deliver a spark from 10 to 12 inches long. The transformer and synchronous motor are mounted rigidly in a cabinet. The X-ray machine is of the interrupterless type, which is superior to ordinary machines which rectify their own current in the X-ray tube.

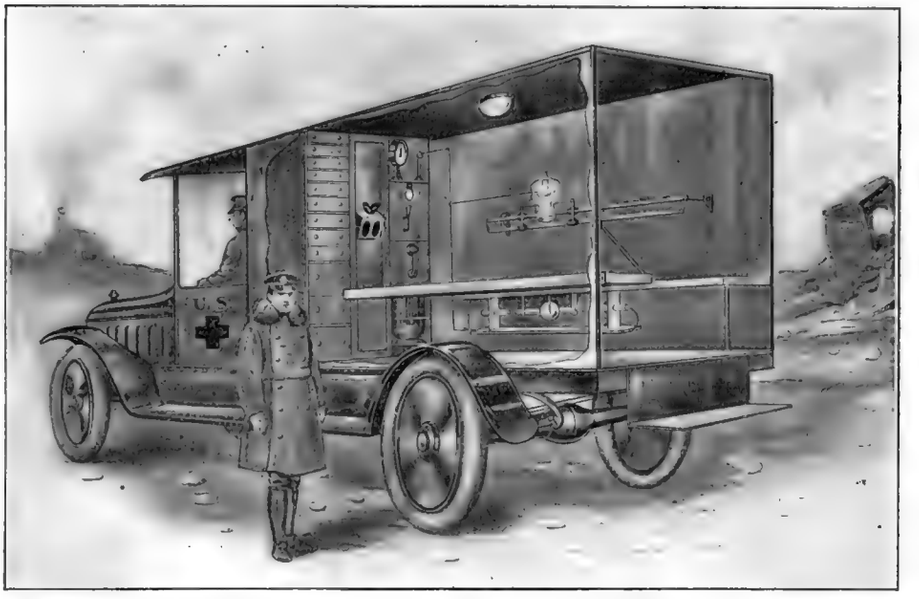
The marble switchboard has all necessary instruments such as a time switch, pole indicator, rheostat, pilot lamps, fuses, and switch; also a volt-ampere meter for the low tension side of the transformer. On top of the cabinet is mounted a milliampermeter for measuring the current which passes thru the X-ray tube.

The Radiographic table is full size and can be tilted 90 degrees. It is equipt with one X-ray tube under the table for Fluoroscopic work and one above for Radiographic work. The lower tube moves in a longitudinal direction, while the upper one moves both longitudinally and vertically. The table has an automatic tray and cassetts (plate holders) into which the plates can be inserted from the side.

As the cabinet is built in sections locked together, it is very easily taken apart and set up with the radiograph table together in a room or inside a house. In this case the automobile would be the power station and a cable would make the connection from the dynamo to the transformer.

In the left corner of the compartment is an instrument cabinet. In the bottom of this cabinet is a lead-lined cabinet for unexposed X-ray plates. Between the X-ray cabinet and the instrument cabinet is a dark room chamber which enables the operator to load the cassetts and to develop the negatives.

On the left side opposite the radiographic table is a leather upholstered seat which folds back into the wall. Occasionally it may be used as a berth. The room is lighted with white and blue electric lights. When the doors are closed it makes a very desirable dark room for Fluoroscopic work.



The Latest Design of Portable X-Ray Ambulance for U. S. Army. It Derives Its Power, About Two Kilowatts, from a Special Dynamo Driven by the Engine. It Includes Plate Developing Facilities, Complete Switch-Board for Controlling X-Ray Bulbs, and Other Necessary Conveniences.

The Blind Now Tape Electric Coils

A SHORT time ago the question of securing some help from the blind was taken up by the Westinghouse people with the Pennsylvania Association, a branch of which is located in Pittsburgh, and a sample lot of motor coils to be taped was sent to the Association in order that the employes might be given a chance to show what they could do. When the coils were returned, it was very evident that this work could be done in an entirely satisfactory manner by those who have been deprived of their sight. Accordingly, arrangements were made with the management of the Association to allow some of their employes to do this work, payment to be made on a piece-work basis.

As this was an entirely new line of work for them, it was decided to have a representative of the Association go to East Pittsburgh to become familiar with the work so as to be in a position to instruct those assigned to do the work. The representative selected for this training was the wife of a former Westinghouse employe, who was deprived of his sight last summer, and who is now employed at the Association. She went to East Pittsburgh and was employed until such time as the management felt that she was sufficiently proficient in the taping of coils to teach the blind and to inspect their work.

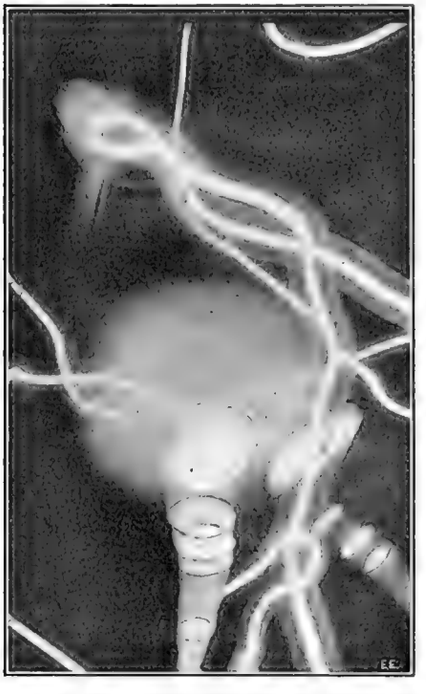
At the present time seven persons are employed and their efforts have been very satisfactory, insofar as quality is concerned. Naturally, as this is new work, the speed is not so great as with those who can see, but this will increase as they become more proficient, and also the number employed will be very materially increased.

It Has Been Found That Blind Persons Can Wind and Tape Electric Coils Quickly and Accurately. Taping Armature Coils.

Some Idea of the Work Done by the Blind May Be Judged from This View, Where All Sorts of Intricate Coils Are Wound and Taped.

One of the employes engaged in this work and shown in accompanying left-hand photograph is Carrol Moore, formerly an employe of the Westinghouse concern. Deprived of his sight, because of his previous familiarity with electrical apparatus, he now finds it easy to adapt himself to taping coils.

Some idea of the broad scope of the organization may be obtained from the fact that last year the sales from the products of the blind employes amounted to over $40,000.



Can You Guess What This Photo Represents?

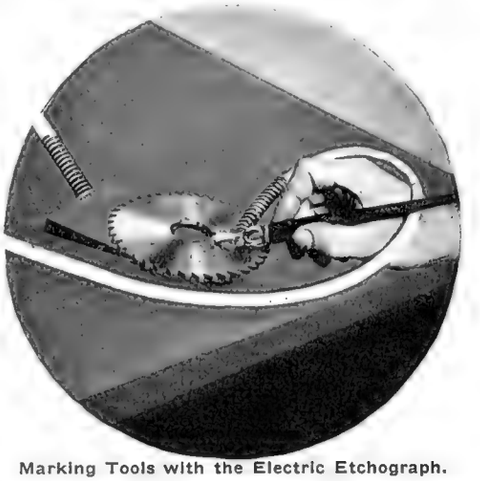
THAT ODD PHOTO!!! IS IT AN ELECTRON?

I was taking a picture of the Mess Hall at the New Trier High School, Winnetka, Ill., with the aid of a flash-light, writes Mr. Lytton Calrow, who submits this very interesting photo in the monthly "Odd Photo Contest." At first we thought Mr. Calrow had really photographed a wild electron shooting thru a more or less tame molecule. But we were in for a bump. Listen to what the contributor has to say:—

The flash-light powder was placed a little in front of a line with the lens and the results are noticed. I have seen several well known instructors in Physics and Chemistry and Optics and none could give me a definite answer as to what the reason for the lines and perfect elliptical figures were. They must be either grains of powder or light waves, it seems to me.

THE ETCHOGRAPH MARKS DESIGNS ON STEEL.

A small portable electric outfit, which can be used to mark small tools and for marking on any steel surface, has recently been perfected. The outfit consists of an electric pencil or "etchograph" and a step-down transformer which can be connected to any lighting socket. To operate the device, the electric pencil is drawn over the steel surface of the work, when great heat is developed at the point of contact due to the high resistance of the iron or steel. The etching depth can be controlled by means of a rheostat. The pencil used, it is said,



Marking Tools with the Electric Etchograph.

can be handled with the same facility as an ordinary pen or pencil, and script writing or any other type of lettering can be used. The outfit is made to operate on 110-volt 60-cycle circuit, or can be used on 110-volt direct current with a small rotary converter.

New Electric Fuse Lighter for Blasting

A California inventor, Mr. Albert S. Cole, has devised a clever and very useful form of fuse lighter operating on electricity supplied from a battery. Where considerable blasting is to be done, it would seem that this apparatus would find extensive favor. The complete electric fuse igniter can be conveniently carried by a coal miner or other person, the battery, spark coil and so forth being enclosed in a small leather carrying case, somewhat resembling those in which binoculars are carried. With this apparatus a stream of electric sparks is obtained between the two metal points protruding from the hand electrode, whenever the battery circuit is closed by pushing the small switch button attached to this hand member in the manner illustrated.

A New Electric Fuse Igniter for Blasting. It Produces a Shower of Sparks Between the Ignition Electrodes Whenever the Button Is Deprest. The Batteries and Spark Coil Are Carried in a Small Case Slung Over the Shoulder

The spark coil may be one giving a ¾ to 1 inch spark. The battery is made up of two or more dry cells, or several flashlight batteries can be employed instead. The stream of sparks obtained with this device serves to ignite the regular blasting fuse in the place of a match. It is possible to build the apparatus at small cost, and it possesses several unique features, one of them being that it is just as efficient on rainy or stormy days as it is on clear dry days, which is not the case when matches or other sources of ignition are employed.

HYDRO-ELECTRIC POWER VERSUS COAL.

The services of half a man are required in central steam stations for every thousand tons of coal used. Therefore the total labor required for the consumption of every thousand tons of coal, on a basis of one year's time, is 2.78 men.

On the average, 1,000 tons of coal in the United States produce 125 h.p. for a year of time; 35,000,000 water horsepower developed and in commission would save the necessity of mining 280,000,000 tons of coal per annum. As regards labor, this vast tonnage requires for its production, transportation and consumption 280,000 x 2.78 men, or 778,000 laborers of one kind and another. The amount of labor required to operate this 35,000,000 water horsepower may be put conservatively at 40,000 men. Therefore the net saving in the way of labor alone by the installation of this water horsepower would be approximately 740,000 men available for other industries

Hydro-electric power is the real efficient energy of to-morrow.

ELECTRICITY CAUSES FEW ACCIDENTS.

While serious accidents to linemen of public utility companies are often caused by electric current, it has recently been found from an analysis of nearly 6,000 accidents among this class of employes that less than 12 per cent of the total number of serious accidents is caused by electricity, and that a very large proportion are the result of carelessness. The following is a detailed analysis of 6,000 accidents occurring to linemen only. Accidents due to electric current are given as 11.4 per cent:

	Per cent.
Striking or struck by material	18.8
Electric current	11.4
Wire, glass, sharp edges	10.0
Handling tools	9.4
Struck by falling bodies	9.4
Lifting or moving material	9.4
Falls from pole	7.3
Acid, solder, or compounds	6.0
Fall from elevation (other than poles)	6.0
Fall on level over material	5.4
Injured by spurs	4.0
Fall from vehicle	2.0
Run down by vehicle	0.7
Injured by animal	0.7

THE WORLD'S LARGEST TRANSFORMER.

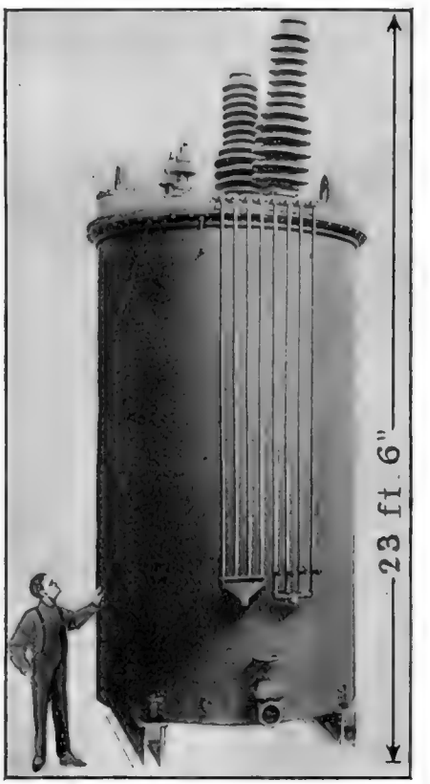
Four of the largest single-phase transformers ever built were recently completed by a large American electrical concern. These units are rated at 14,000 kva., 60 cycles, and since they have a 25 per cent overload rating they are practically 17,500 kva. (kilowatts at 100 per cent power factor), maximum rated transformers. These transformers will operate at the high transmission voltage of 150,000 volts.

These transformer units will form one 42,000 kva. bank, which, together with a spare unit will make the preliminary installation to step up the voltage from 13,200 —that of the water-wheel generator. Power will be transmitted about 25 miles to an industrial plant where it will be stept down by means of a number of 7,000 kva. single-phase transformers of similar characteristics.

Owing to the large size of the units themselves and the great amount of generating capacity which will ultimately be concentrated behind these transformers and their need to be able to withstand the effects of momentary short-circuits the shell type of transformer with special end frames and bracing arrangements was selected. Structural steel for these parts was used thruout, because the strength of the various members can be depended upon to a much greater degree of certainty than with castings. The top and bottom ends of the coils are held against distortion by two heavy steel plates each re-enforced by four lengths of angle iron riveted to them and held together by four heavy tie-rods.

The tanks are made of heavy boiler plate, all seams being welded by means of the oxy-acetylene process.

Some idea of the physical size of these units may be gained from the fact that the height measured 23 feet 6 inches over the high tension terminals and the units weighed complete with oil and fittings around 110,000 pounds. Note the relative size of the man standing beside one of these gigantic transformers.



The World's Largest Transformer—Rated at 14,000 Kilowatts Normal or 17,500 Kilowatts at 25 Per Cent Overload. Compare with Figure of Man.

Making Electricians Over Night

THE war has changed many things. If we were a speedy nation before the war, our national speed certainly has increased to a surprising extent ever since we entered the struggle.

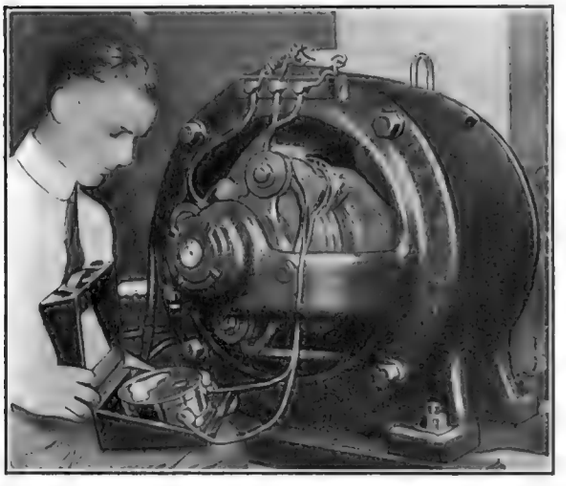
Years ago a German writer called America "The land of unlimited possibilities." His brothers are now finding out this truth to their hearts' content. Indeed, it seems as if there is no end to what we can accomplish, but if we are to win this war we must husband *all* our forces, not only in materials, but in human efforts as well. War economies are not only effected in wheat, beef or coal, but the saving of human time is an enormous factor if we are to win this war. It will not do alone to turn out 91 ships in one day or sending a million men to France six months ahead of the schedule. It is the man behind the man behind the gun who helps just as much to win the war.

If we can save a great amount of time for our workers we save just that much in dollars and relieve just so many more workers for other endeavors which we could otherwise not do.

Time was when it took from three to four years to turn out an accomplished electrician who could be entrusted with any job that came along. Only a few years ago it used to cost thousands of dollars to make an accomplished electrician, which amount was made up in expensive tuition, board, etc., as well as money lost in non-production while the student was learning. Hundreds of thousands of dollars were lost in this manner because the student, seldom, if ever, is a producer while studying. This means a tremendous loss to the nation, as a minute's reflection will readily show.

However, nothing amazes us any longer in these stirring days. We are indeed doing the impossible in all branches of human endeavor. While we say today: "It can't be done," along comes a chap who has already done it and thinks it commonplace.

Out in Chicago in the "I Will" city, they now have a big machine (which isn't patented, either), where they feed raw, lanky youths in thru a hopper at the top of the roof and three months later full fledged electricians, with diplomas in their hands, walk out thru the school door ready to tackle any electrical job anywhere at a minute's notice!



The Most Practical and Resourceful Electrician Is the One Who Has Actually Made the Test On a Dynamo or Motor Himself.

This seems hard to believe when one stops to think how many things the student must learn before he can call himself an accomplished electrician. His knowledge not only lies in the theoretical learning, but he must know how to do things with his own hands. While the fundamental knowledge can be readily obtained from books, the accomplished electrician necessarily must know how to do things out of his own experience, and unless he has the equipment to do it with it usually proves a long and tedious job.

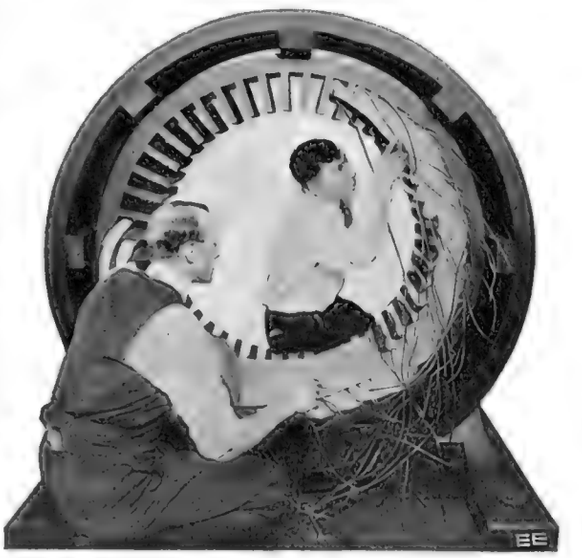
The concentrated instruction necessary to turn out a modern electrician is being practised and it is quite amazing to see how quickly students become experts in nearly everything electrical in this school. In walking thru the instruction rooms we find students ranging from eighteen to fifty busy at work—practical work—in every conceivable branch of electricity. In one room we find a large number of students getting instruction in wire splicing. An instructor standing among them shows them just how it is done, explaining everything necessary, and then the pupils are taught how to splice the wire themselves. Here also they do soldering, testing motors and generators, while in other rooms we find them wiring lamps, telephone systems, lighting systems, as well as electrical sign systems. Next we see them at work operating a motor flasher, while another class is studying switch circuits. There are also classes handling every kind of installation work.

The writer on a trip thru this institution watched students at work on meters, testing motors, transformers, alternators, induction motors, etc. He watched them winding stators, repairing arc lamps and doing all sorts of every day routine work on starting, lighting and ignition systems.

In still another room are seen students working on spark coils as well as operating all kinds of motor control apparatus, testing watt meters and building switchboards.

It is quite surprising to find what a huge equipment is collected under the roof of a school of this kind, but on the other hand a minute's reflection will reveal that unless such a tremendous equipment was provided the practical instruction would of necessity be faulty. As a matter of fact, if the students are bright and alert at all, they will themselves demand to see as well as do work upon almost any imaginable sort of electrical devices. Hence, it did not surprise the writer to find that there was even an electrical locomotive upon which the students worked!

Besides teaching electricity the school also teaches practical draftsmanship, and there are also plumbing and brick laying departments. *Photographs Courtesy Chicago Coyne Trade and Engineering Schools.*



The Way to Learn Motor and Dynamo Winding Is to Actually Do the Work With Your Own Hands, As This Student Is Doing.

STATIC ELECTRICITY AND GASOLINE EXPLOSIONS.

Sometime ago there was much discussion by several authorities on whether static electricity resulting from pouring gasoline thru chamois could ignite gasoline or not. In connection with this an inquiry has arisen from a reader regarding static electricity when filling tanks, especially motor cars, with gasoline says a contemporary publication. This has been the cause of fires. In reply thereto, a Canadian Insurance Inspector reports as follows:

"The fire danger inherent in static electricity is present only when the *chamois skin* is used as a lining for the funnel or other filling apparatus. The use of chamois skin suggests itself because of the property of chamois to pass gasoline but to retain water.

"It has been found that when gasoline runs thru a metal funnel with chamois skin, static electricity is released which in a few cases on record has generated a spark and ignited the contents of the tank. It has been demonstrated experimentally that a spark is generated *only when the funnel is held in midair,* without making *contact* with the metallic gasoline tank itself.

"Since electricity seeks the shortest path, it is advisable to ground the chamois-lined funnel, by permitting it to make contact with the metal walls of the gasoline tank. This way all danger is avoided."

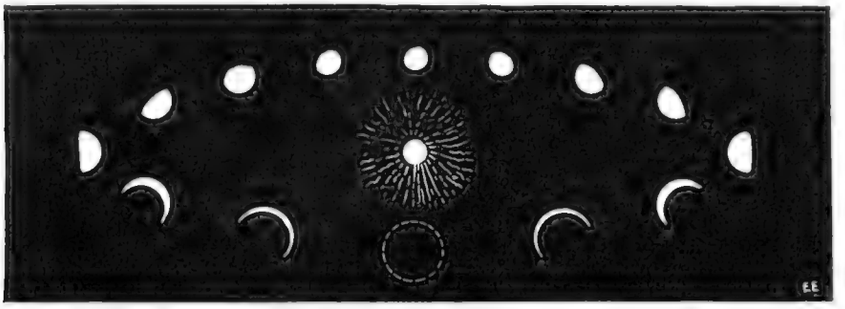
A case in point of the effect of the hazard of static electricity occurred on July 2nd when an auto truck of the Imperial Oil Company at its filling plant in Vancouver, took fire. The wagon was being filled from the tank and the driver had not made the proper ground connection, the tank being insulated by the automobile tires. During the process of filling, static electricity was generated, making a small explosion which ignited the liquid in the tank truck.

Popular Astronomy

THE SUN AND HIS SATELLITES—THIRD PAPER

By ISABEL M. LEWIS
Of the U. S. Naval Observatory

OUR sun is but a star traveling thru the universe at the rate of thirteen miles in a second. It is accompanied in this journey to unknown parts of space, that lie in the general direction of the constellation Hercules, by an extensive family of minor bodies, the eight major planets and their encircling moons, twenty-six in number, one thousand or more asteroids, and numberless comets and meteors, all moving in prescribed paths around their ruler whose intense light and heat are the result of his comparative nearness. Seen from the distance of the stars he would be only one star among the hundreds of millions of stars that form the visible universe.



Venus in Different Parts of Her Orbit as Seen From the Earth. The Direction to the Earth Is Toward the Bottom of the Page. The Planet Mercury Shows These Same Phases. Neither Planet Can Be Seen When in Line or Nearly in Line With the Earth, Except on the Rare Occasions When They Transit the Sun or Pass Directly Between the Earth and Sun, When They Appear as Black Dots Projected on the Sun's Disk. Usually They Pass Just Above or Below the Sun and Are Then Invisible, Due to the Glaring Light. Mercury Is Never More Than 29 Degrees or Venus More Than 47 Degrees From the Sun.

The most important members of the sun's family are the major planets, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, named in the order of their distance outward from the sun. We hear occasionally of the possibility of the existence of inter-Mercurial and trans-Neptunian planets and some day an additional planet may be discovered within the orbit of Mercury or beyond the orbit of Neptune. The gravitational power of the sun extends far beyond the orbit of Neptune and there seems to be some evidence pointing to the possible existence of two planets on the outskirts of the solar system. The question of the existence of a planet within the orbit of Mercury is now, after long continued and diligent search, considered to be settled in the negative.

Were it possible to view the sun from the distance of the nearest star with the aid of the greatest telescope on earth all the members of his family would be hopelessly invisible. So, also, we cannot tell as we point our powerful telescopes at the stars whether these other suns are attended by planet families. We may only argue that it is very unlikely that there should be but one star among hundreds of millions that is attended by a group of comparatively small dark bodies that shine by the reflected light from the star they encircle.

With the exception of the two planets, Mercury and Venus, spoken of as the inferior planets, since their paths lie between the earth and the sun, all the major planets have moons or satellites of their own that encircle the mother planet just as the mother planet encircles the sun.

Our planet earth has one satellite, the moon, that has the distinction of being the largest moon in proportion to the size of the mother planet. Jupiter and Saturn have moons that surpass our moon in actual size, in fact, two of the moons of the outer planets are actually larger than the smallest major planet Mercury but they are very small in proportion to the size of the planets around which they revolve. Mars,

Saturn and Its Three Concentric Rings Composed of Swarms of Moonlets in Revolution Around the Planet. Note Divisions in the Rings and Also Belts on the Planet Parallel to Its Equator.

the next planet beyond the earth, the nearest of the superior or outer planets, has two tiny moons that bear the names of Deimos and Phobos. They are both less than ten miles in diameter and revolve very near to the surface of Mars. They can only be seen in very powerful telescopes. The inner moon Phobos is unique in the solar system for it makes three trips around Mars while the planet is turning on its axis or experiencing one day and night.

Jupiter the next planet outward from the sun is almost a sun himself in the eyes of his extensive family of nine moons. Four of these were first seen about three hundred years ago when Galileo pointed his first crude telescope at the heavens and any one can now see them with the aid of an opera glass. One of the four is equal in size to our own moon; the others surpass it in size. These moons are most interesting little bodies to observe and they have figured in some important astronomical discoveries as well. Their eclipses in the shadow of Jupiter, occultations or disappearances behind his disk, and the transits of their shadows as well as the bodies themselves in front of the planet are all phenomena of importance to astronomers and are therefore publisht in the almanacs of all countries for every day that the planet is visible. The five remaining moons have all been discovered in modern times. They are extremely small bodies visible only in large telescopes. Satellite V is the nearest of all the moons to Jupiter. The other four are at great distances from the planet.

The planet Saturn has nine moons. Titan, the largest, is nearly equal in size to Jupiter's largest moon and is therefore larger than Mercury, four of the other moons have diameters between one thousand and two thousand miles in extent. Since Saturn is nearly twice as far from the sun as Jupiter his moons are much more difficult to observe, tho the two largest are visible in small telescopes.

Saturn is unique in the solar system in possessing in addition to his nine satellites a most wonderful ring sytem composed of swarms of minute moonlets, each pursuing its individual path around the mother planet. It is this unusual ring system that makes Saturn the most interesting to observe telescopically of all the planets.

The planet Uranus has four satellites and Neptune one. Neither of these planets nor any of their satellites can be well observed on account of their great distance from the earth. The indistinctness of surface markings makes it impossible to determine the period of rotation of these two outer planets on their axes. It is believed to be very rapid, however, as is the case with the other outer planets Jupiter and Saturn. All the planets in the solar system fall naturally into two groups. Jupiter, Saturn, Uranus, and Neptune, the members of the outer group, have on the average, diameters ten times as large and therefore volumes

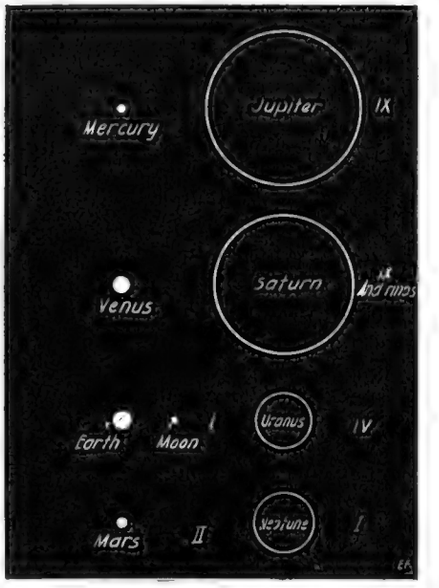


Diagram II. Relative Sizes of the Major Satellites of the Sun, and the Earth's Satellite, the Moon. The Distance of the Moon From the Earth Is Sixty Times the Earth's Radius and Is therefore Not Drawn to Scale. The Scale of the Diameters of the Planets Is Twenty Thousand Miles to One-half Centimeter. Note the Comparative Sizes of the Terrestrial Planets on the Left and the Outer Planets on the Right. Roman Numerals to the Right of Each Planet Represent the Number of Its Moons Discovered to Date.

one thousand times as great as Mercury, Venus, Earth and Mars, the members of the inner or terrestrial group.

The terrestrial planets are the pigmies of the solar system, the outer planets are the giants. The density of the planets Mercury, Venus, Earth and Mars averages nearly five times that of water. One, at least, of these planets supports many varied forms of life.

The existence of life on Mercury is made impossible by the absence of an atmosphere. Venus and Mars both have atmospheres and there is a strong possibility that both of these planets may support life. Mars has probably been the most discust of all the planets tho Venus is the Earth's twin planet in size, mass, density, and surface gravity just as Uranus and Neptune are the twins of the outer group. It is now believed that water and vegetation exist on Mars. The reddish color of this planet is supposed to be due to its extensive desert tracts. The existence or non-existence of certain surface markings on this planet, the "canals," still continues to be a matter of dispute. It is reasonably certain, tho, since air, water and vegetation exist on Mars that some form of animal life also exists there.

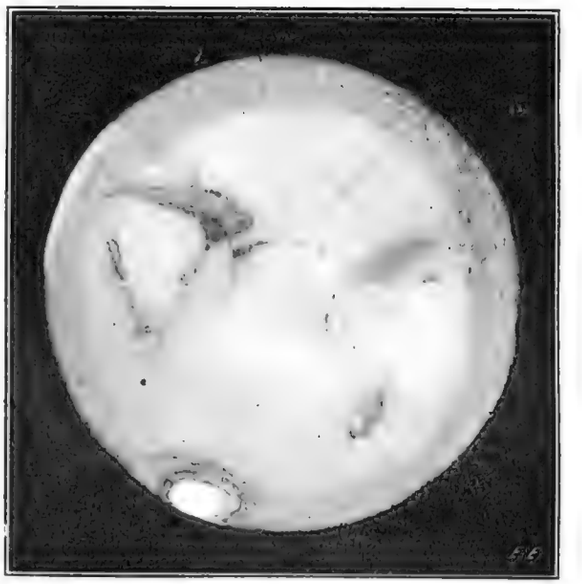
The question of life on Venus depends largely upon the length of its rotation period which is still uncertain since no definite surface markings can be found on this planet. So dense is the atmosphere of Venus that it appears to be always hidden from view beneath a canopy of clouds. It is the general belief that Venus, as well as Mercury, rotates on its axis in the same time that it takes to make a revolution around the sun. In this case the same side of the planet would always be turned toward the sun and under such circumstances life on Venus would be very difficult due to great extremes of heat and cold.

This peculiar form of rotation is by no means unknown in the solar system.

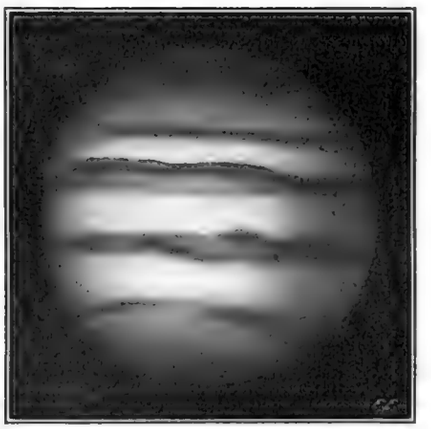
Diagram 1. Relative Positions of the Orbits of the Eight Major Planets. The Three Inner Circles Represent the Orbits of Mercury, Venus and Earth, Named in Order of Their Distances Outward From the Sun. The Orbits of the Planets Are Ellipses, Not Circles, but They Cannot Be Distinguisht From Circles in a Drawing of This Size. Within the Asteroid Belt Are Found the Majority of the Asteroids, but Not All of Them. The Revolution of All the Planets and Asteroids Is in the Direction of the Arrow, From West to East. On the Scale of This Diagram the Nearest Star Would Be Distant Four-fifths of a Mile.

Our own moon always keeps the same face turned toward the earth and the evidence seems to be that some of the satellites of Jupiter and Saturn rotate in the same way. The length of the day on Mars is known very accurately on account of the rareness of its atmosphere which enables us to see some of its surface markings. Its length is about 24½ hours and its seasonal changes strongly resemble our own.

Life on any one of the outer planets is impossible. The density of these planets averages about the same as the density of the sun which is a little higher than the density of water. The density of Saturn is even less than water. In other words, Saturn would float in water and it is the lightest of all the planets. It is assumed from these facts that the four outer planets are largely in a gaseous condition. They all possess dense atmospheres and in spite of their huge size rotate on their axes with great rapidity. The two whose rotation periods are known, Jupiter and Saturn, turn on their axes in about ten hours. On account of this rapid rotation and their gaseous condition both Jupiter and Saturn are noticeably flattened at the poles. Both of these planets have a number of dark belts parallel to their equators and faint belts have also been seen on the planet Uranus. According to one explanation these belts are fissures in the planets' upper atmospheres thru which the lower denser atmospheres are seen. The rotation of the planets on their axes would cause these openings to lie parallel to the equator.



The Planet "Mars"—After a Drawing By Alfred Rordame, Made December 3, 1911. Note the Canal Lines, Which In the Larger Telescopes, Are Plainly Discernible.



Jupiter and His Belts. Photographed By E. C. Slipher of the Lowell Observatory, Flagstaff, Ariz. Generally Considered the Best Photograph of Jupiter Ever Made.

The terrestrial planets are separated from the outer group by a wide gap. Within this space are to be found the asteroid or planetoid group. There are known to be over nine hundred and fifty of these minor bodies whose diameters range from five hundred miles for the largest to three or four miles for the smallest. There are only four asteroids whose diameters exceed one hundred miles and the majority have diameters of less than twenty miles. The total mass of the asteroids is much less than that of the smallest of the major planets. It was believed at one time that these small bodies were fragments of a shattered planet but this view is no longer held. The asteroids as well as the comets and meteors may represent the material of the primitive solar nebula that was not swept up when the larger planets were formed.

With few exceptions the asteroids are only to be seen in large telescopes and then only as star-like points of light. Most of them are simply huge rocks and all are necessarily devoid of life since such small bodies have not sufficient gravitational force to hold an atmosphere.

Law and order prevail among the different members of the solar system. The revolution of the planets around the sun and of the satellites of the planets around the primary planets are performed according to known laws that make it possible to foretell the positions of these bodies years in advance. Asteroids and comets also obey the laws of the solar system and after three observations of the positions of one of these bodies have been obtained their future movements can be followed. There is, moreover, a uniformity in the form and motions of the planets and their moons that is considered significant in connection with the origin of the solar system. All the planets and their satellites are nearly perfect spheres. They all, with few exceptions, rotate on their axis and revolve around the sun or, in the case of moons around their primaries in the same direction from west to east. When the noted nebular hypothesis was advanced to explain the origin of the solar system the exceptions were unknown. They are now considered to make doubtful the truth of the hypothesis. These exceptions are the two outermost satellites of Jupiter, the outermost satellite of Saturn, and the satellites of Uranus and Neptune. All these bodies *retrograde* or travel in their orbits in a direction opposite to that of all the other planets and satellites.

The paths of all the planets around the sun are nearly circular and they all lie in nearly the same plane. The asteroids have orbits that are more flattened or elliptical and these orbits are in some instances highly inclined to the planetary orbits. The comets have orbits that are usually very elongated ellipses or parabolas. Some of the comets may be only temporary members of our solar system tho astronomers generally believe that they are all perman-

(*Continued on page* 340)

The Gyro-Electric Destroyer—Once More

The Pro and Con of Mr. Gernsback's Idea of Winning the War with the Gyroscope

HAVING read with a good deal of interest and thought Mr. Gernsback's articles in recent issues of the ELECTRICAL EXPERIMENTER in regard to winning the war by building 45-foot monsters called Gyroscopics, which would spread defeat and consternation in the ranks of the Hun, I beg to take issue with him on the feasibility of this plan, regardless of its astounding features:

In the May issue, he says editorially:

"This war, more so than any other, is a machine war. A stereotyped phrase, but, nevertheless, a very true one. When we speak of a machine war, we usually have in mind artillery of all calibres, from machine guns upwards to 42 cm. guns, and larger. We believe that we will not be contradicted when we state that vast bodies of infantry can not move forward nowadays without the support of protecting artillery from the rear. Logically, the conclusion follows that if we can annihilate the enemy's artillery, he must fall back. Even trench systems without artillery support from the rear can not be held for any length of time by the enemy. If our artillery is intact, but if the enemy is deprived of his, even tho his infantry should outnumber ours ten to one, he would have to retreat just the same. These, of course, are very obvious facts."

According to reports from the fighting fronts this is true enough without the endorsement of the General Staff. In the next paragraph he writes:

"The British now engaged in the Western war theater realized this truth very early and set about to rectify it. The result was their present Tanks. These machines fulfill several purposes; they are used to batter down the barbed wire entanglements protecting front line trenches; secondly, they raise havoc among the enemy's men by flank fire once across his lines, but most important of all the Tanks are supposed to annihilate the enemy's artillery either by putting the artillerists out of action by gun fire from the Tank or by climbing right over the enemy's guns, thus putting them *hors de combat*. For the first two purposes the Tanks are ideal; for the latter they have signally failed. The reason is very simple. The Tank is an extremely slow-moving vehicle in the open field—five to eight miles an hour at the most is its speed. Even if camouflaged a Tank makes a shining mark for the enemy gunners, who find little trouble in getting the range of the slowly crawling tractor. One or two shells soon puts the most ambitious Tank out of business."

Another truth, and he might have added, if the Tanks have any real military value where are they in the past big (Allied) drive? One would expect to read in the news dispatches where the Tanks like bits of Gibraltar stood out in the open and stemmed the advance, but such has not been the case. It has been proven that in a warfare where nothing can live above the ground, and even steel and concrete projections have had to give way to the power of the big guns, the Tanks offer no defense at all, for any purpose. When steel turreted forts like those along the Belgian frontier suffered such damage and were practically blown out of the ground, what possible defense could a Tank or even a Gyroscopic put up in the face of such a fire, with their limited crew and supply of ammunition, especially when the batteries of the enemy are capable of plowing up every foot of ground. A few well directed shells of the 42 cm. type would be sufficient to put them *hors de combat* without further ado.

The Gyro-Electric Destroyer, Here Illustrated, Was Fully Described in Our February, 1918, Issue. This 45-Foot Monster Is Steered By a Large Gyroscope Wheel, Shifting the Latter Either to the Right or the Left. The Wheel Made of Lattice Steel-Work Is Practically Proof Against Stray Shell Shots. The Destroyer Runs at a Speed of From 40 to 60 Miles an Hour and Due to Its Huge Diameter It Rolls With Ease Over Trenches and Other Obstacles.

Mr. Gernsback states:

"In other words, the large and speedy machine obviously is the thing in this war. In former articles we have shown that it is perfectly feasible to run monster machines over land at speeds from twenty miles upward."

Possibly, but how could it be done in the mud of Flanders? The Gyroscopic with its heavy bulk would sink axle deep in the mud. Its success would depend upon dry ground and smooth ground at that. Even if it could succeed in passing the enemy's barrage and run down first line trench batteries and machine guns, it would still have high power guns several miles back to contend with as well as guns at a much nearer range, and would be practically blown to pieces before it could over-run them.

By this reasoning we are able to see that no machine of the Tank or Gyroscopic type can expect to achieve a decision in this war. It is in the air that we should look for results. Swiftly moving bombing planes which offer little target to the enemy can be depended upon to put the enemy's batteries out of business, no matter where they are located. As many military experts have stated the decision will be in the air. The side that controls the air will have the advantage. With thousands of bombing planes covering the Western front it would be impossible for the Hun to set foot on a bit of safe ground. With all the talk of the Allies devoting their efforts to building a large fleet of planes, it appears that very little has been accomplished in this direction. Because if they had how was it possible for Germany to assemble the immense forces and materials on the Western front for the past spring drives.

According to the Tank and Gyroscopic defense idea, we wait until the enemy has assembled all his forces and munitions for the drive before they are called on for action. On the other hand, the bombing plane checks the enemy while he is trying to assemble his supplies, by hunting out the most vulnerable points of attack. I can say without fear of contradiction that a suitable supply of bombing planes would make a big offensive impossible, by bombing everything above ground. Nothing can escape these bombs; they are everywhere at once, carried by swiftly moving planes, capable of returning to a base for more and resuming the havoc. The Tank and Gyroscopic could attain no such speed or return for supplies. Once in the work they must go on until their supply of ammunition is used up and become the prey of the enemy.

While it is evident that this is a machine war, and the Tank has been tried and the Gyroscopic suggested, I am confident that the need will be accomplished with men, munitions and bombing planes. Men and munitions, of course, are everything, but in addition to these, the practical value of the bombing plane has been proved over the Tank and Gyroscope, and they will bring results unless some inventive genius brings forth some new type of land battleship, which must necessarily come, because men alone cannot stand the awful havoc of battleship guns, now used for the first time on land. Inasmuch as no modern forts, Tanks or Gyroscopics can withstand them, other means, one of which is the bombing plane, must be found to overcome them.

LOUIS LEON,
Director.

Rochester, N. Y.
Leon Telegraph & Wireless School, Director Wireless Telegraphy, Mechanics Institute.

Mr. Leon's criticism is well taken, but I regret that I cannot agree with him. Quite the contrary.

My answer resolves itself into the one word: SPEED. In my article in the February 1918 issue of the ELECTRICAL EXPERIMENTER I stated explicitly:

"As we have pointed out before, what is wanted is a machine, not necessarily monstrous and weighing many thousand tons, but one that need not weigh more than the present Tank, and that can cover ground rapidly, so that it becomes almost impossible for the enemy to get the range."

I furthermore said:

"It should also be noted that only a very moderate speed of the motors is necessary, inasmuch as the diameter of the wheel—45 feet—is so large that it will move at the rate of from *forty to sixty miles an hour* with the motors running at very slow speed."

Now if Mr. Leon knows of any method to train a large calibre gun and score a hit on an object 45 feet high and less than 20 feet wide running at more than express speed, I'd like to hear of it. Always remember that a Gyro-Electric Destroyer under fire would run at all times a slightly erratic course, (let us say, a steep zig-zag). Under such conditions a direct shell hit is impossible, and any artillerist will tell you so. The enemy simply can not get the range of the swift moving monster. It could only be hit by a very remote chance. The zig-zag tactics coupled with the high speed of the destroyer have their true counterpart in the modern battleplane, flying thru a heavy barrage of anti-aircraft fire. An aeroplane pilot caught in the midst of a barrage (providing he flies low enough) immediately begins to "pancake," or else to loop, dive or climb. He never stays at the same level for more than 10 seconds, and consequently the gunners below never get his range. He simply laughs at them, while he zig-zags *vertically*. Indeed, there is no greater dishonor for a modern air-fighter than to be shot down by anti-aircraft guns. It is very seldom done nowadays, the real battles being fought in the air between the contending flyers.

I therefore insist that no large calibre gun can possibly put the Gyro-Destroyer out of business. As to small calibre guns, let them shoot at it. They will do as much damage as a machine gun does to a Tank. The armor of the Destroyer will not mind it any more than a rhinoceros minds buckshot.

Regarding the large guns, our Destroyer simply runs over them or runs them into the ground. Or the crew may elect to slow down when approaching one of the large guns. Then from one of the side turrets a few small bombs are dropt on or under that gun, wrecking it in a few seconds. Then on to the next gun.

As for the bombing planes, I am just as great a believer in them as Mr. Leon. We certainly do need them, and if we can only make them fast enough to get them "over there" it will surely help to drive the Huns from the air and bring our day of victory nearer. But bombing planes *alone* will never win the war any more than Gyro-Destroyers *alone* can win it. But both will unquestionably prove of great help.

Of what good are Mr. Leon's bombing planes against large calibre guns, well camouflaged, and invisible from above. What good are the bombing planes against an intrenched enemy? What good are they against a Hun division sneaking up under cover of night? Mind you, I am not attempting to minimize the tremendous importance of the bombing plane, but by itself it will not win the war. Germany did not win the war, and she has thousands of bombing planes. So have we and our Allies, but they have not won the war for us.

Again I say, the enemy *must* retreat if he has no guns to put down a barrage with which to prevent us from getting at him. Destroy his guns, and he must fall back. And the Gyro-Electric Destroyer can and will do all this with comparative ease. And by its help the lives of thousands of our splendid boys will be saved.

Exactly as the Hun submarine is helpless against our fast moving destroyers—for it can not get the range quickly enough—so the Hun gunner is helpless against our Gyro-Destroyer. And just as our boys in blue drop a depth charge on the prowling U-Boat, so will our boys in Khaki drop a bomb on the German Gun.

Mr. Leon says: "How could the Gyro-Destroyer run thru the Flanders mud?" The answer is simple: It doesn't! Why should it? Guns cannot advance thru mud either, nor does an army as a rule. Both contending forces, if mud separates them, are deadlocked. But we can run over dry land, and there is always plenty of that somewhere, *and we can then take the enemy from the rear* and destroy his guns, before he knows what is up. Then if our infantry follows the Destroyer there will be an end to the deadlock in that section behind the Flanders, or any other mud field.

THAT "OCTOBER" ELECTRICAL EXPERIMENTER

Something new—an automatic bullet-proof, steel plated electric soldier—that will hold the front line trenches against all odds.

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The Latest Electrical and Wireless Photos from the American Front.

The Telephone Girls with Pershing Overseas.

Spectroscopic Methods and the Production of Spectra—A sequel to the article "How to Build a Spectroscope," in the August number, by Donald S. Binnington.

The Revolving Mirror—*How to photograph an oscillating spark discharge, popularly explained by Prof. Lindley Pyle.*

The Burnt-Out Lamp Prize Contest—Second Spasm.

Ohm's Law and the Alternating Current Circuit. An Article Every Radio and Electrical Student Must Read, by Arno A. Kluge, Instructor in Radio, University of Nebraska.

Glass Blowing in the Experimental Laboratory. It Tells You the How and Why. Part II. By Prof. Herbert E. Metcalf.

Besides One Hundred Other Live, Wide-Awake, and Timely Articles on Electricity, Physics, Radio, Chemistry, Mechanics, and Astronomy; and All the Usual Departments.

Nowhere in my articles did I mention that the Gyro-Destroyer could or would win the war, but I did say:

"We are quite confident that a machine of this kind should do as good work as a thousand men in the field, and, perhaps, better."

I still maintain that I am right, until *actual experience* with such a machine proves me wrong, and that I firmly believe won't happen.

* * * * *

In connection with the above a curious thing is happening of late. I am in receipt of many letters from "Experimenter" readers, and I reproduce a few below. These letters are fair samples of the many that come to my desk, but I will let them speak for themselves:

Editor Electrical Experimenter:

In reference to your May Editorial and some of the preceding ones. I wish to state that I am totally in sympathy with you as far as this "Monster Land Battleship" is concerned. I am well acquainted with the details of it, as I have read your recent magazines as well as some of a few years ago where you have also presented a machine of that kind but of a different construction. I am also with the same opinion in reference to the "Tanks" for I have seen one and its clumsiness.

Now in order that you may not appeal in your Editorials without results I would suggest, that, being your circulation reached the 100,000 mark, and naturally all those who read the ELECTRICAL EXPERIMENTER cannot but be interested, should patriotically contribute $1.00 to the Editor, and the Editor should dispose of all such money by building and perfecting one of those Giants and prove to the Government its effectiveness.

For the Government at the present time is overburdened with the enormity of its war tasks and it hardly has time for experimentation.

I personally would be more than willing to make such a contribution and would urge it upon all those whom I know to be readers of your magazine.

JOSEPH SEAR,
No. 422 South Fourth St.,
Philadelphia, Pa.

* * * * *

Editor Electrical Experimenter:

The Gyro-Electric Destroyer which adorns the cover of the February, 1918, issue of the "E. E." is a mighty interesting looking monster, and, if practical, would no doubt give an account of itself on the battle field.

I suppose the Government, deluged with ideas of all sorts, and overwhelmed with the expense of carrying out its army building and army moving programme, does not care to invest in anything that departs so far from the usual.

Nevertheless, looking at the thing on paper, and dreaming of its possibilities if it would work, makes one very anxious to see it tried.

Therefore, this letter and suggestion. Why not get every "E. E" reader, and all others possible, to donate one dollar to defray the expense of building one of these craft and trying it out?

If it works, turn it over to Uncle Sam. If it doesn't, the loss is ours, and we won't holler.

(*Cont. on page* 347)

Editor Electrical Experimenter:

I enclose herewith $..... as my contribution towards building a model of your Gyro-Electric-Destroyer.

You are to build as large a model as the funds will permit and the money is to be used for the sole purpose of building this war machine. You agree to publish an exact account of all funds spent and all contributions are to be acknowledged thru the columns of the *Electrical Experimenter.*

You pledge yourself to construct the machine as quickly as possible and you will turn it over to the U. S. Government immediately upon its completion.

Name.....

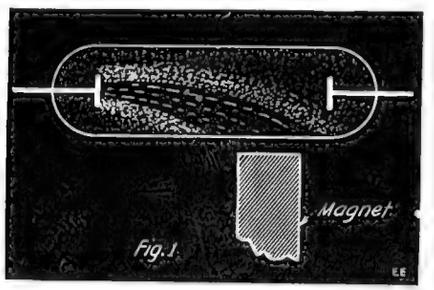
Address.....

The Phenomena of Electrical Conduction in Gases

PART V—WEIGHING AN ION

By ROGERS D. RUSK, M. A.

AS large as the earth is it has been weighed, and as small as the smallest ion is it also has been weighed, and measured many times. We are accustomed to think of one as infinitely small, and yet in this great universe of ours the earth may be hardly an atom of



The Way Ions Are Deflected By a Magnetic Field. A Pretty Experiment Easily Made With Simple Apparatus.

the whole, and beyond the electron there may be SUB-ELECTRONS, *divisible again and again.* Scientific investigation extends both toward the ultra-great and toward the ultra-small but to the student of electricity the latter field is the more interesting, because it leads us on toward the solutions of the problems as to what electricity and matter really are.

In previous papers it has been shown how the *velocity* of an ion may be measured, the methods of production have been mentioned, and the causes of disappearance have been explained. All these quantities can be very definitely measured, but more than that the weight of an ion can be measured, also its electric charge and its size or volume.

When it was first attempted to obtain the weight of an ion, or more technically speaking the *mass,* something was discovered of startling significance to the scientist and which may revolutionize all of our scientific views. Matter of any kind had always been described as that which possest mass and this property had always been considered the most unfailing and unvarying attribute of all matter. In fact, it was the one quality by which matter was defined and distinguished from non-matter, but when in weighing the ion it was discovered that this seemed to be untrue, a new wave of scientific thought developed which is gathering force as it goes, and bids fair to change completely many of our present ideas.

For a long time scientists were unable to measure either the mass of an ion or its charge by any direct mehod so that in order to obtain some idea of the magnitude of these two quantities it was customary to measure the quantity $\frac{m}{e}$, or the mass divided by the charge. This quantity was easily attainable because it occurred in many equations concerning ions, and if the charges were considered the same on all ions, it gave the relative masses; or if the masses were considered the same, it gave the relative charges. On account of the fact that all *univalent ions* in solutions carry the same charge it has been customary to apply the same notion to ions in gases.

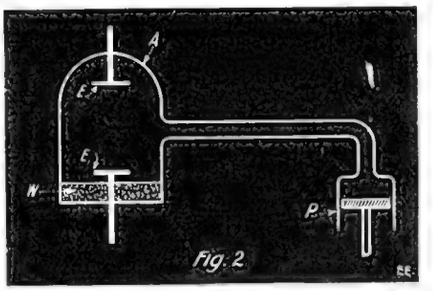
The simplest method of measuring $\frac{m}{e}$ is called the energy method of J. J. Thomson. It is a well known fact that the energy of any moving body is $\frac{1}{2}$ m v^2, and if this be the energy of one electron the total energy of N electrons is:

N $\frac{1}{2}$ m v^2 = W,—which may be measured in terms of the amount of heat generated when these rays fall on a metal plate. But the number of electrons N, is equal to the total charge Q, divided by the charge on each electron e, and the equation becomes

$\frac{Q}{e}$ $\frac{1}{2}$ m v^2 = W or transposing terms;

$\frac{m}{e} = \frac{2W}{Qv^2}$ So when the heat W.

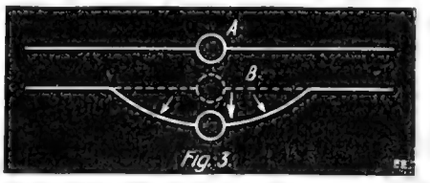
the quantity of electricity Q in the gas, and the velocity v, are measured it is an easy



The Expansion Chamber By Which An Electric Cloud Is Formed.

matter to calculate the ratio of $\frac{m}{e}$.

There are many other ways of measuring the same quantity chief among which is a method depending on the fact that positive



A, The Field About a Stationary, Electric Charge; B, The Way a Field Resists Motion, Or Its Inertia.

or negative ions may be bent by a magnetic force. As the magnetic force on the ion depends on the charge on the ion, and as the amount the rays are bent will vary inversely as the mass of the ion, it is readily seen that the amount of bending can be measured in terms of these quantities and set equal to $\frac{e}{m}$ or the reciprocal of $\frac{m}{e}$. Fig. 1 represents the deflection of ions by magnetism, in a tube similar to that used for measuring the velocities of ions.

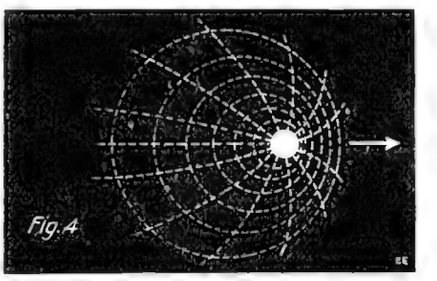
Now to measure the mass of an ion or to weigh an ion all that is necessary is to find the quantity of electricity carried by each ion and substitute it for e, in the quantity m divided by c, then solve for m the mass.

The first step then is to measure e, the charge on an ion, and this like other similar processes can be accomplisht in several ways, but practically all methods for measuring e, which have been developed so far depend on the fact that drops of water can be made to condense about ions and if sufficient ions are present a cloud is formed. It had been suspected for some time that the presence of dust particles in the air was one of the causes which made moisture collect in drops and fall as rain. In 1897, C. T. R. Wilson made the discovery that in dust free air clouds would form if electrified particles or ions were present. This discovery was immediately followed up by H. A. Wilson, J. J. Thomson and others, who made use of the new fact to enable them to determine the charge e, on an ion.

As is well known the complete or total charge in an electrified gas can be readily measured by driving these ions by means of an electric field to a plate connected with an electroscope or electrometer. If the number of ions were known it would be a simple process to divide the total charge by the number of ions, and obtain the charge on each ion. Up until Wilson's discovery the counting of such minute particles as ions had been an utter impossibility. Now assuming by the laws of probability that only a negligible number of drops would form about two or more ions at the same time it was only left to count the drops and take this as the correct number of ions. In order to insure as great accuracy as possible very small drops were used, and instead of being visibly counted their number was estimated in the following manner:—A single drop was observed in a microscope and its weight calculated from its diameter. Then the whole cloud was weighed and this total weight divided by the weight of a single drop. This gave the number of drops. The total charge was then measured as suggested above and divided by the number of drops. This then was the *charge on the ion,* and two birds were killed with one stone for now the mass could be gotten from the various values which had been obtained for ratio of the mass and charge.

A typical apparatus for producing such a cloud is shown in Fig. 2. A is the expansion chamber and P is the pump by which a known expansion can be obtained; E, E are the electrodes. When the piston is pulled down the air in A suddenly expands and very rapid evaporation takes place

(*Continued on page* 355)

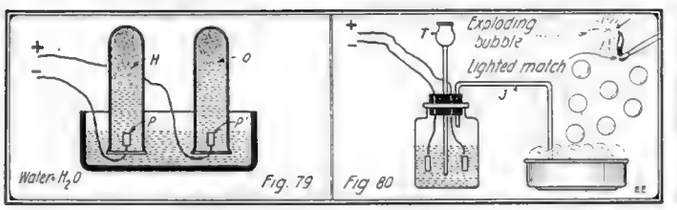


The Complete Field of a Rapidly Moving Electric Charge.

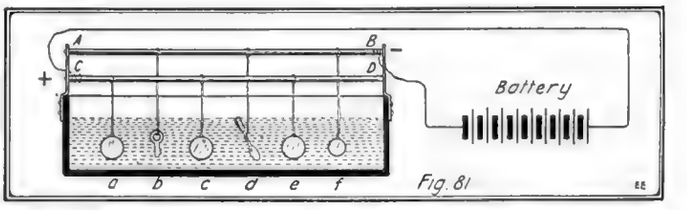
Experimental Physics

By JOHN J. FURIA, A. B., M. A., (Columbia University)

LESSON FIFTEEN



Two Basic Experiments of Intense Interest to Every Lover of Electro-Physics. Fig. 79—The Electrolytic Decomposition of Water and Fig. 80—Forming Water From Its Constituent Gases, Hydrogen and Oxygen.



"Electro-Plating" Experiment Which Proves Very Interesting and Educational. The Electric Current From a Battery or Small Dynamo Causes the Metal Ions to Deposit on Spoons, Keys, Etc., Resulting in What Is Known as "Plating."

CURRENT ELECTRICITY
(Continued)
Experiment 87.

PLACE a few drops of sulfuric acid in a small vessel of water (see Fig. 79). Fill two test tubes with this dilute solution of sulfuric acid and invert them in the vessel as shown. Lead current from storage battery or other sources of at least ten volts to platinum electrodes P and P^1 (steel nails will do fairly well if platinum is not available). Bubbles of gas will appear rapidly, the negative electrode filling its test tube *twice* as rapidly as the positive. On testing we find that the gas at the *negative* electrode burns with a *blue flame* (a test for HYDROGEN). The gas at the *positive* electrode does not burn; but a glowing splinter when placed in the gas burns brightly, i. e., the gas supports combustion (a test for OXYGEN). CARE MUST BE TAKEN WHEN MAKING THESE TESTS TO KEEP THE TEST TUBES INVERTED; OTHERWISE, THESE GASES, BOTH BEING LIGHTER THAN AIR, WILL ESCAPE. Modern theory explains this phenomenon, *electrolysis,* as follows: When the sulfuric acid is dissolved in the water, it breaks up, into positively charged Hydrogen ions and negatively charged sulfate ions. The current causes an electric field to be established in the solution between the electrodes. The hydrogen positively charged ions are attracted by the negative electrode and repelled by the positive electrode. On reaching the electrode their charges are neutralized and the ions combine and form Hydrogen gas. The negative ions move to the positive electrode, their charges are neutralized, they react with the water liberating Oxygen and forming additional sulfuric acid. The fact that we find that two parts of Hydrogen are given off to one of Oxygen is one of the reasons for believing that each *Molecule* of water is composed of *two atoms of Hydrogen and one atom of Oxygen.*

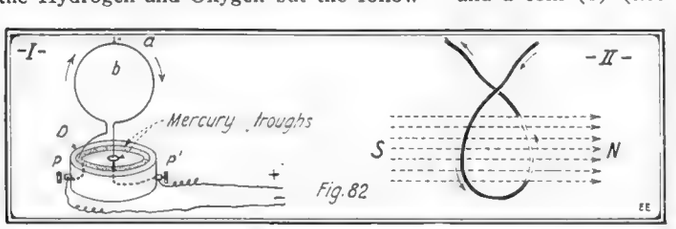
EXPERIMENT 88—Just as water can be decomposed into its elements Hydrogen and Oxygen, the elements in their right proportions can be mixed and water formed. Any of the methods can be used for securing the Hydrogen and Oxygen but the following is the simplest in which to secure and mix the elements in the correct proportions. (See Fig. 80). The jar contains dilute sulfuric acid. Electrodes, thistle tube T, and J-tube, are connected thru a tightly fitting rubber stopper. MAKE SURE THAT THE THISTLE TUBE ACTUALLY IS IMMERSED AT LEAST HALF AN INCH IN THE SOLUTION: THAT THE ELECTRODES ARE TOTALLY IMMERSED AND THAT THE "J" (TOP) TUBE IS NOT IMMERSED. The other end of the J-tube is immersed in a porcelain crucible or china cup containing a soap solution such as one uses for making good soap bubbles. When the current is turned on the solution in the jar breaks up into two parts Hydrogen and one part Oxygen, as in the previous experiment. The gases mix in these proportions in the space above the solution and pass out thru the tube into the soap solution forming bubbles of Hydrogen and Oxygen, each bubble containing two parts Hydrogen to one part Oxygen. The first few bubbles contain the air of the space above the solution and should be blown away. Then touch the bubbles with a lighted match. A loud but harmless explosion will result (harmless because it is an inward explosion rather than an outburst) and *water is formed.* The use of the thistle tube is obvious. Should the pressure of the gas in the jar become large because the gas is not escaping thru the J-tube as rapidly as it is generated, there would be danger of an explosion and of the jar bursting. Instead, as the pressure increases some of the solution is forced up the thistle tube, making more room for the gas and also causing less surface of the electrodes to come into contact with the solution. This principle is extensively used in gas generators to avoid accidents.

EXPERIMENT 89—Place a solution of copper sulfate in a vessel (See Fig. 81) AB and CD are heavy copper wires insulated from each other and connected to a battery of at least ten volts (D.C. house current is very good for this experiment). To the *positive* wire connect some pennies or other pieces of copper (a), (c) and (e); to the *negative* connect a key (b) a spoon (d) and a coin (f) (not copper). On passing the current thru, (b), (d) and (f) become copper-plated, the speed of the action depending on the current. In a similar manner by using silver instead of copper and a silver salt instead of copper sulfate we can silver-plate articles suspended on the negative wire. Using nickel and a nickel salt we nickel-plate, and with gold and a gold salt we gold-plate. CARE SHOULD BE TAKEN TO CLEAN WELL THE ARTICLES TO BE PLATED. The explanation is similar to that of electrolysis of water. The dissolving of the salt in the water causes the salt to dissociate into the *positive metal ion* (copper, nickel, silver, gold, etc.) and into the *negative ion* (sulfate, chlorid, etc.). The positive metal ion is attracted to the negative electrode because of the electrical field established, loses its charge and deposits itself (or plates). The negative ion passes to the positive electrode, gives up its charge and combines with the metal to form more salt which in turn dissolves (the sulfate ion loses its charge and combines with the copper to form copper sulfate, which goes into solution). Thus the strength of the solution is maintained and the metal at the positive wire is eaten up.

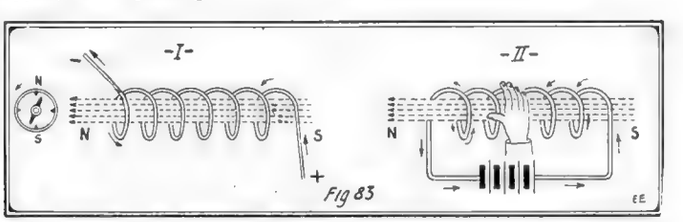
EXPERIMENT 90—*Electrotyping* is an important application of electroplating. Set up in common type the page to be electrotyped. Stamp it in wax or other compound prepared for taking moulds. Coat the wax impression of the type with grafite powder to make it a conductor of electricity. Suspend this at the negative electrode of a copper-plating outfit as described in Experiment 89. When a sheet of copper about 1/75 of an inch thick has been deposited on the wax mould, remove it from the solution and peel off the wax and replace it with molten type-metal backing to give strength to the copper facsimile. From such an electrotype many thousand impressions can be made.

EXPERIMENT 91—In the last lesson we learned that electricity in motion is always accompanied by a magnetic effect (Oersted's experiment) and we learned the rule for determining the direction of the magnetic field knowing the direction of the current. Let us look into this effect a little further.

(*Continued on page* 350)



Demonstrating the Rudiments of the Magnetic Circuit and Its Relation to the Electric Current Producing the Magnetic Field. A basic Rule Everyone Should Know.



These Diagrams Show the Direction of Current Flowing Thru a Helix or Magnet Coil to Produce a N. and S. Pole. Also How the "Right-Hand Rule" Is Applied to Magnets.

Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decreed that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of the ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

U. S. Signal Corps Radio Outfit in France

THE Radio Division of the U. S. Signal Corps has been wonderfully enlarged since our entrance into the great world war, and thousands of portable wireless outfits are being assembled and shipt to Europe at this time. The accompanying photograph shows one of the Signal Corps Radio Squads on duty in France. A collapsible telescopic mast is usually supplied with this apparatus so that the antenna can be raised or taken down at a moment's notice.

When the troops are entrenched in dugouts, then the radio men install their apparatus in a well protected underground cavern and lead their antenna wires from the apparatus up thru dark passageways and out to the aerial itself. In trench warfare the antenna is a low affair not extending over three to four feet above the trenches. The antenna under these conditions is given a fairly good length to make up for the low altitude.

Photo Copyright by Committee on Public Information.

One of Pershing's Signal Corps Squads Operating a Portable Radio Outfit in France.

When the army makes a rapid advance, then the radio crews move forward with the troops and carry their wireless apparatus and aerial paraphernalia on mules or horses, or still more often nowadays, on auto trucks, some of which are assigned to the radio divisions for the purpose. There are also a large number of portable wireless outfits mounted in auto trucks which can travel over the field very rapidly, and which can be put into operation in less than a minute's time. These wireless trucks carry a telescopic aerial mast made of steel tubing, and are provided with special means for quickly raising and lowering the mast.

QUICK TRANSMISSION OF TELEGRAPH OR RADIO MESSAGES.

Altho there are 26 letters in the English alphabet only 23 are used frequently, the ones very seldom used are "X, Y, Z." As "Y" is used more than the other two we will discard it. We then take "X" and "Z."

1st Proposal: "X" alone indicates the word "the." "Z" alone indicates the word "is." "X" may also indicate "a" or "an." If you were to write "they" just write "xy." Writing the word "and" write "xd." In writing the sentence "*The* boy *is* good *and* he will go with *them*," all you write is "X boy z good xd he will go with xm." If you were to write "his" just write "hz." "Business" would be written "bzness."

2nd Proposal: To eliminate, wherever practicable, all final "e's," such as "stone, line, lime, practice, etc." The above words would be written "ston, lin, lim, practic, etc."

3rd Proposal: In such words as "Experimenter, longer, water, writer, seeker, feeler, stronger, quicker, etc.," I would eliminate the "e" before the final "r," and the words would then be written as follows: "Experimentr, longr, watr, seekr, feelr, strongr, and quickr." "Also the "e" before "d" as "stored" = 'stord."

4th Proposal: "X" at the end of a word would indicate "shun" as in "Induction, fiction, traction, fashion." The above would be written as "Inducx, ficx, tracx, and fax." The "shun" in centers of words can also be written "Faxable." "Z" at the end of a word would indicate "able." "Disabled, fable, table, etc.," would therefore be written "Dzzd, fz, tz, etc."

5th Proposal: "Z" at the beginning would indicate "st" as in "stick, stayed, stem, steamer, etc. They would be written as follows: "zick, zayd, zem, and zeamr, etc."

Contributed by
"One of your Radio Bugs,"
E. LAUFER.

Four working parties building a railroad across Australia keep in touch with one another by wireless telegraphy.

American naval officers are installing a wireless telegraph station in France.

The Temps announces that the station will be ready for use in August to correspond with the station in Annapolis. It will cost $2,500,000. After the war the station will be taken over by the French.

YOUNG ROCKEFELLER LEARNS RADIO.

There is hardly a wealthy family in the country that does not have its boys in the service; and, in the draft, the New York district where the fewest exemptions were claimed was the district in which the richest

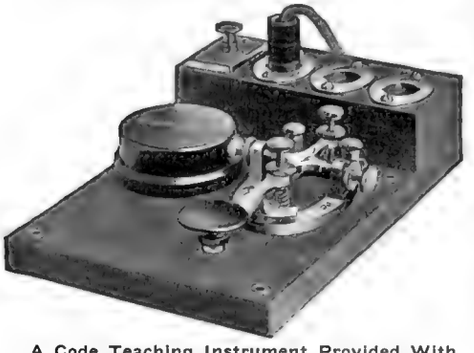
Photo by Paul Thompson

Private W. A. Rockefeller of the U. S. Aerial Naval Patrol, Studying Wireless Telegraphy.

families live. Private W. A. Rockefeller, of the U. S. Aerial Naval Patrol, if commissioned, as he hopes to be, believes he can see his way clear to outfitting himself completely—provided, of course, the dealers give him reasonable time. He is the son of the late William G. Rockefeller and grandnephew of John D. He is here seen practicing the wireless code with an Omnigraph, the standard code machine used by the Army and Navy schools.

A COMPACT CODE TEACHING INSTRUMENT.

As can be seen in the accompanying photo this new code teaching set consists of a wooden base on which are mounted a sending key, a buzzer, a battery switch, and three connection sockets. These sockets are marked "Bat.," "Omni.," and "Line," and are used respectively for connection to the Battery, the Omnigraph, and the Line. The Omnigraph connection may or may not be used, as desired, but is included in case the student desires to practise receiving from an outside source.



A Code Teaching Instrument Provided With Plug Switch for Battery and Omnigraph.

The line connection is used only in cases where it is desired to receive thru head receivers, in which cases the head receivers are connected by plugging into this socket. In the event that more than one pair of head receivers is to be used at a time, they may be plugged into a connecting cord and in turn connected to the line connection in the set. This set has incorporated in it a ballast resistance which makes it possible to connect any number of head receivers without interfering with the sound of the buzzer.

The set shown herewith is furnished complete with two three-foot cords for connection to the Battery and Omnigraph, but does not include Battery, Omnigraph or Head Receivers.

UNCLE SAM PAYS $1,600,000 FOR POULSEN PLANT.

The Poulsen Wireless Telegraph & Telephone Company has sold its wireless rights and plant in the United States and dependencies to the U. S. Government for $1,600,000. This payment has already been made, while important deals are said to be pending for the sale of Poulsen rights for use in other countries.

SWEDISH RADIO TALKS TO PALESTINE.

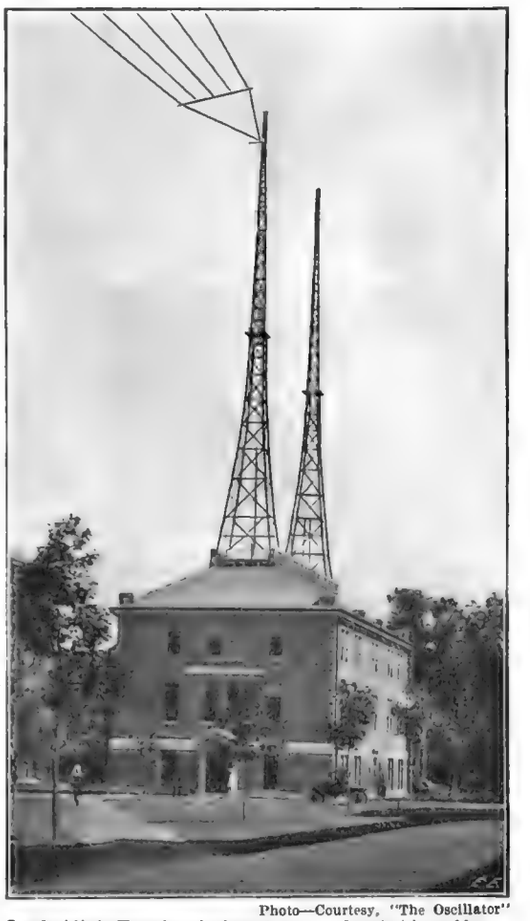
Sweden's most powerful radio station, situated at Karlsborg, has been put into operation. Regular communication is now being conducted with Dutch Altenburg in Austria, and also Tsarskoe-Selo. Messages have also been exchanged with Spanish stations and Constaninople. Word has been received that the Karlsborg station's messages have been read by a little station in Damascus, Palestine, altho the Damascus station's plant is too weak to reach Karlsborg.

CRUFT HIGH TENSION RADIO LABORATORY.

The accompanying photograph shows the excellent building and lofty latticed-steel aerial masts at the Cruft High Tension and Radio Laboratory at Cambridge, Mass. This laboratory which was built several years ago, was used as a special research laboratory prior to the declaration of war by the United States. It was formerly used by the U. S. Naval Radio School at Cambridge, but it is not now directly used by this school.

The Cruft Laboratory was built to carry on high class wireless and allied high tension research work, including such measurements as the quantitative and qualitative tests of radio signals, the determination of the operating characteristics of radio transmitting as well as receiving apparatus, wireless telephone experiments and tests, etc. Considerable work has been done at this laboratory in the short time it has been in operation including a large number of experiments on the wireless telephone of Prof. Chaffee.

The laboratory is fitted up with a complete equipment of the various measuring instruments necessary for conducting tests along these lines, and constitutes one of the best equipt laboratories of its kind available today.



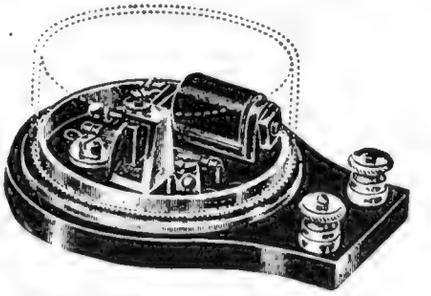
Photo—Courtesy, "The Oscillator"

Cruft High Tension Laboratory at Cambridge, Mass., Where Some Remarkable Experiments Have Been Conducted.

A CONSTANT TONE RADIO BUZZER AT LAST

For a hundred and one purposes the radio man daily finds that he needs a constant tone test buzzer. For all accurate measurements of wave length and decrement such a buzzer is absolutely essential. It has remained for a well known English concern to bring out such a buzzer, which sells for something like nine dollars, but it is worth it.

This instrument, the result of exhaustive experiments, will operate continuously at constant amplitude without changing its periodicity, and the note is instantly variable by the movement of a cam, say its sponsors. A pure musical note with a range of three octaves can be obtained. Sparking at the contact points is entirely eliminated



New Constant Tone Radio Buzzer.

by a small grafite rod which can be shunted either across the coil or the platinum contacts, and if desired cut out entirely.

The Einthoven Galvanometer—Its Theory, Operation and Construction

By SAMUEL D. COHEN

THE electrical measuring instrument is the most important asset to the electrical and radio experimenter, and it would be impossible for him to study the actual characteristics of any electrical piece of apparatus without the aid of it. Voltmeters, ammeters and wattmeters are the ones used to the greatest extent by the engineer. However, the most important of them all is the ammeter, especially when it is used to measure a minute quantity of electricity flowing thru a given circuit. This instrument in its finer term is called a *galvanometer*. A galvanometer is a delicate and sensitive electrical instrument used for measuring very small electric currents. To the radio experimenter and engineer, the galvanometer is found to be most useful, insofar as unimaginably small currents are dealt with, especially in the radio receiving circuit where currents of one-thousandth part down to a few millionths of an ampere flow.

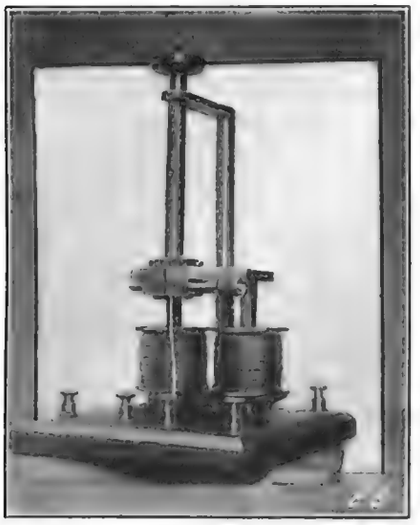
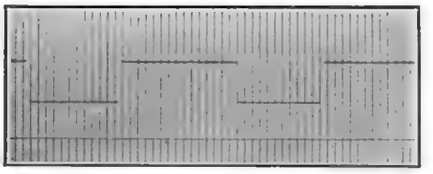


Fig. 3. Einthoven Galvanometer As Built By the Author and Which Shows a High Degree of Sensibility. This Type of Galvanometer Is One of the Simplest to Build, and It Is Suitable for Use In Recording Radio Signals and Other Extremely Minute Currents. The Construction Cost Is Very Small.

Practically all galvanometers with which the student is familiar consist of two main parts, a coil of wire thru which the current can flow to be measured, and a permanent steel magnet constituting the field. This is the moving coil type. In other forms of this instrument, the coil is comparatively large and is rigidly fixt to the frame of the instrument, while the magnet is a small piece of steel suspended lightly by a fiber of untwisted silk or quartz. In other galvanometers the arrangement is reversed, and the coil or part carrying the current is made as light as possible and placed in a very powerful magnetic field produced by a large electro-magnet, which usually forms the body of the instrument. The latter type of instrument is the one in which we are interested, as it has proven to be the most sensitive of them all.

Even in this class of galvanometer, there are two types, the one developed by Prof. Korn, who utilizes two, fine parallel wires suspended in a powerful magnetic field, and a second form devised by Prof. Einthoven, who uses a fine, single silvered quartz wire placed in an extremely powerful magnetic field. The latter was found to be far more sensitive than the former, and this type of galvanometer will therefore be described in this article.



Record Obtained With the Einthoven Galvanometer Showing "Make and Break" Curve of a Current of 1.3 Micro-Amperes. The Average Radio Signal Has a Strength of Forty Micro-Amperes. The Time Interval Between the Vertical Lines Is .055 Second.

Several years ago the author constructed a very simple Einthoven galvanometer. Altho not as sensitive as the commercial ones, it gives fairly accurate results in experiments which he conducted in radio receiving circuits. The instrument was sensitive enough to record radio received currents from distant transmitting stations.

A commercial form of Einthoven galvanometer is shown at Fig. 1. Here A represents the powerful magnetic poles excited by the huge electro-magnets, B. B. The case, E, contains the fine wire carrying the current to be measured. Fig. 2 shows schematically the arrangement of the suspension for the fine wire E, which must be as fine as possible. Platinum, silver or aluminum can be used, but it was found that even a smaller diameter can be obtained by using quartz or glass fibers, these being platinized or silvered. The ends of the wire are soldered to T-shaped members, which are held by two set screws placed at the ends. Adjusting the tension of the wire is a close operation and it is carried out by mounting the upper wire carrier upon a rod having a cam at the upper end, the rod being normally pushed up by a spring. With this arrangement a very fine adjustment of the wire is secured, connection being made to the ends of the wire.

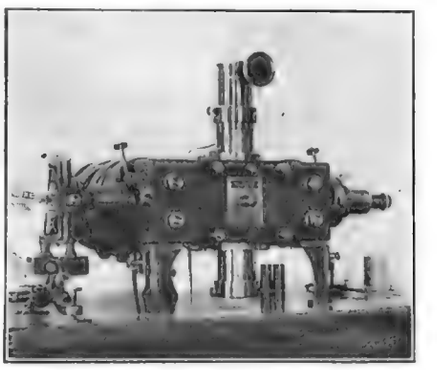


Fig. 1A. A Special Form of Einthoven String Galvanometer Used In a New York City Hospital In Recording the Beat of the Human Heart. This Galvanometer Is So Extraordinarily Sensitive That the Minute Electric Currents Generated at Every Beat of the Heart Actually Cause the Instrument to Register a Deflection on a Moving Photographic Film.

The method of noting the displacement of the wire when carrying a current in the magnetic field is shown in Fig. 2. An eyepiece, AE, is inserted in a hole in one of

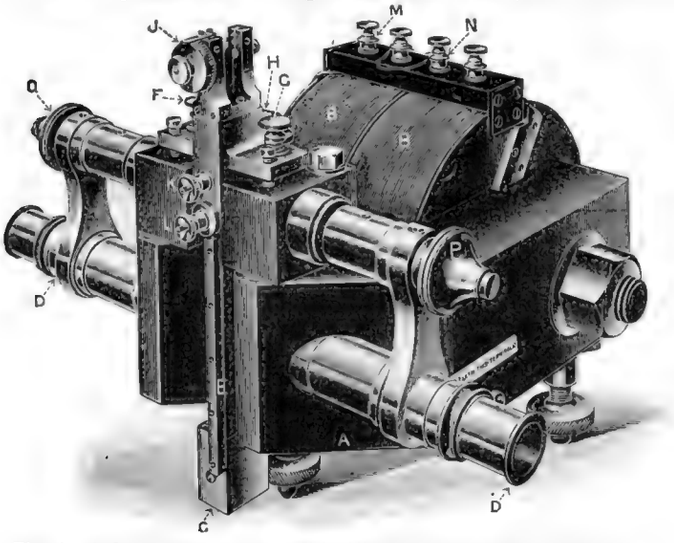


Fig. 1. A Commercial Type of Einthoven Galvanometer Which Has Been Extensively Used In Making Quantitative Radio-Telegraphic Measurements Such As the Strength of Received Signals, Etc. The Holder or Carrier Supporting the Galvanometer Thread Between the Powerful Magnetic Poles Is Removable for the Replacing of the Filament. The Observer Looks Thru the Pole-Pieces and Sees the Deflections of the Filament By Means of a Telescope Shown at D, D.

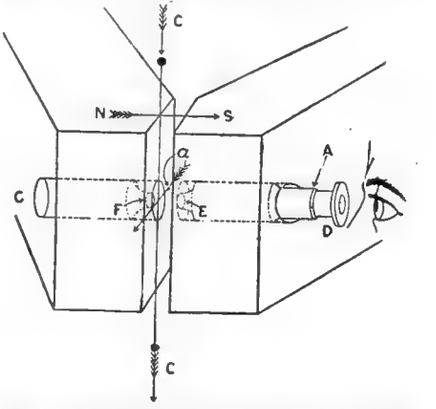


Fig. 2. Diagrammatic view Thru the Einthoven Galvanometer Magnet-Poles, Showing How Deflections of the Filament or String "C C" in the Direction of the Arrow "a," Are Viewed Thru the Telescope.

the magnet poles, and the light is projected by the tube C and the lens F. The wire is stretched between the points CC, and with the flow of the current in the direction indicated by the arrows, a deflection is obtained as shown by the horizontal arrow "a," which is at right angles to the magnetic field NS. Even a minute movement by the wire is greatly magnified by the telescope. For projecting on a screen, the eyepiece is removed and by sending a powerful light ray thru C, we see the image of the middle part of the wire on the screen. The screen is placed one meter away from the wire, inasmuch as the deflection will vary with the distance. The instrument may be calibrated to note the amount of current necessary to produce a deflection of one millimeter division at one meter distance. This is a standard of calibrating all types of galvanometers.

It was found from actual experiments in determining the sensitiveness, that the string will be displaced one millimeter for currents as small as 10^{-12} ampere ($\frac{1}{1,000,000,000,000}$ or one one-trillionth of an ampere). Several millimeters or even centimeters of deflection can be obtained with the aid of the optical instrument and with currents of values of 30 to 40 micro-amperes, (one micro-ampere = one one-millionth ampere). It is thus seen that the instrument is extremely sensitive.

Some of the most valuable features of this instrument are:—its quick action, its dead beat, and its quick period of swing, this being due to the almost negligible weight of the moving part, its moment of inertia being extremely small. Also it possesses practically no self-induction or capacity. It was found that with a wire of standard length and thickness which is one-thousandth of an inch thick, that the period of the wire is $\frac{1}{1,200}$ of a second. This is small enough for practically all speeds of code reception used by commercial radio companies.

To determine the period of the string by actual measurement is a difficult problem. However, the following may be found of interest, especially to the more advanced student of electricity. If a short current be sent thru the string by means of suddenly tapping a key connected with the string, it is given a jerk and is displaced thru a distance d (at the center). It then swings back to zero and then past the zero point, due to the slight moment of inertia which it possesses. Calling this distance X, the point is thus d-X from it, where d-X is less than d. If a damped oscillation is sent thru the wire, the string does not actually come to rest for a definite time. During this time there may be a complete vibration from which the natural period t/n can be ascertained. If the string be made to cast a shadow over an illuminated slit thru which the light passes when it is displaced, and this light falls on a rapidly traveling band of a highly sensitive photographic film, and a tap be then given with a key or switch, a record of the movement of the string is obtained. If the rate at which the film travels is known, it is a simple matter to calculate the period of the string of the galvanometer.

The string has a shorter period if its length be shortened or its tension increased, and the damping of the oscillation can be effectually increased if a twist be given to one end of it.

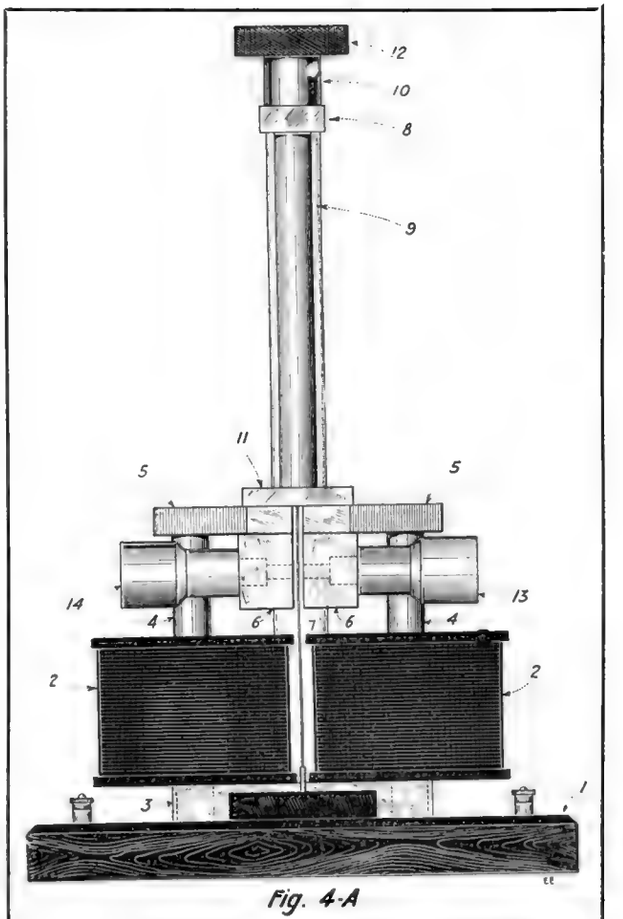
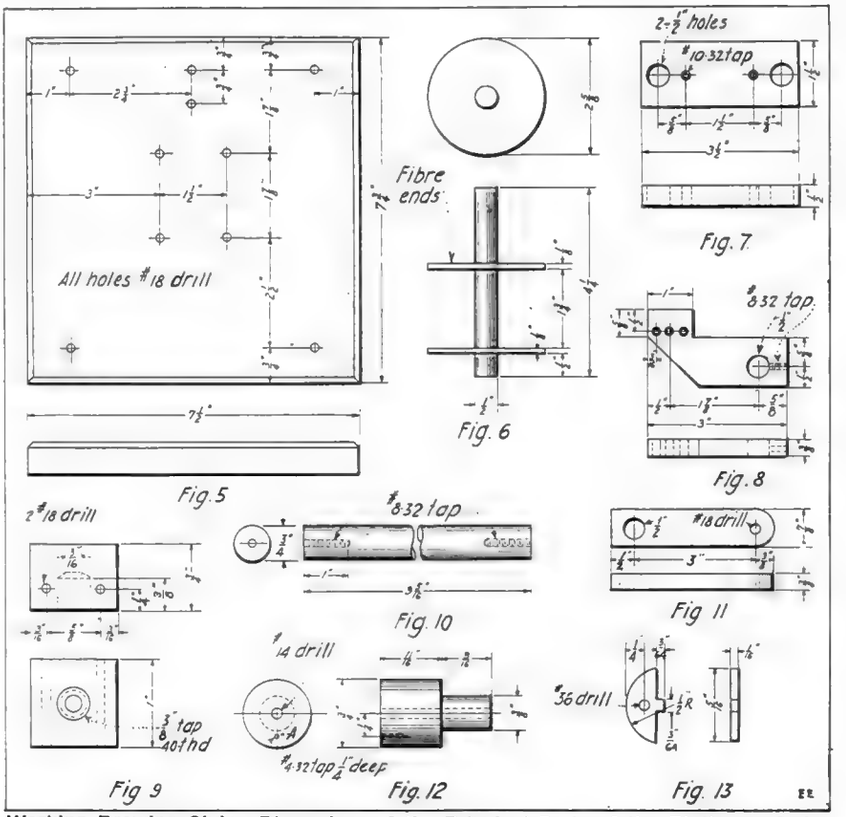


Fig. 4. Assembled View of the Home-Made Einthoven String Galvanometer, Showing Field-Magnet Coils and Adjusting Screws As Well As Base Suspension Block for the "String." The Telescope Members Are Screwed Fast to the Pole-Pieces By Blocks at 6, 6.



Working Drawing Giving Dimensions of the Principal Parts of the Einthoven String Galvanometer Here Described. All of the Parts Are of Very Simple Design, and Can Be Made With a Little Care By Any Amateur Mechanic Without the Aid of Any Elaborate Machine Tools at All.

It is thus seen from the above discussion that the character of the string, its material and manner of suspension has a great deal to do with the sensitivity of the instrument. Also the intensity of the magnetic field wherein it is placed has considerable to do with its sensitiveness. The table below gives an excellent idea of the period of the string, its resistances, etc.

This will suffice for the discussion on its operation. Let us now turn our attention to the more important topic for the constructor, namely giving the reader complete dimensioned details on the construction of a sensitive Einthoven galvanometer, which the author built several years ago. Fig. 4 is a photograph of the completed instrument. This galvanometer was used for experimental work in radio-communication and its sensitiveness was found to be three-hundredths of a milliampere for one millimeter deflection at one meter distance from the screen. This was found to be sensitive enough for practically all kinds of work where small currents were dealt with.

Detail assembly of the galvanometer is given in Fig. 4-A. The base 1, is made from three-quarter inch hard wood stock, and the drilling lay-out is given in Fig. 5. All holes are to be drilled with a No. 18 twist drill. The magnetic field is derived from two electro-magnets 2, 2, and their construction is shown in Fig. 6. The core is a piece of wrought iron one-half inch in diameter. The ends are machined down to four and one-quarter inches. Two fiber bobbin checks are placed on each end. Two holes are made in the lower end with a

(*Continued on page* 345)

A Graph for Solving Wave Length Frequency Inductance and Capacity

By E. M. T. (RADIO ENGINEER)

THIS graph gives a comprehensive view of the relation between resonant frequency and concentrated capacity and inductance over a range somewhat more extensive than is at present covered by wireless telegraphy. In fact, the graph is equivalent in length to 16,000 miles.

In order to do this logarithmic scales must be employed for in no other way can the enormous ranges of values be suitably shown. Logarithmic scales are quite simple and their use should not deter anyone, not familiar with logarithms, from understanding and using the graph. It is suggested, however, that the definition of logarithms be reviewed in the unabridged dictionary.

In many ways this graph is superior to the tables for a similar purpose as given in Zenneck's book, and in the Smithsonian book of Physical Constants or to the Graphs in the Eccle's Hand-book.

As an example in the use of this chart let it be required to determine the resonant capacity to be used with an inductance of 10^5 centimeters, in an oscillatory circuit to vibrate at 600 meters wave length. First locate the point in the right-hand column of the chart corresponding to 10^5 (100,000) cms. Follow the horizontal line across until it intersects the diagonal line labeled with the desired wave length, in this case 600 meters or frequency of 500,000. Where these two lines intersect drop down along the vertical line to the bottom of the chart, where it is ascertained that .001 m. f. is the right capacity to be used with the inductance chosen. With 10,000 cms. of inductance, and 600 meters wave length, the capacity reads .01 m. f. Any other capacity, inductance, wave length or frequency can be found in this manner.

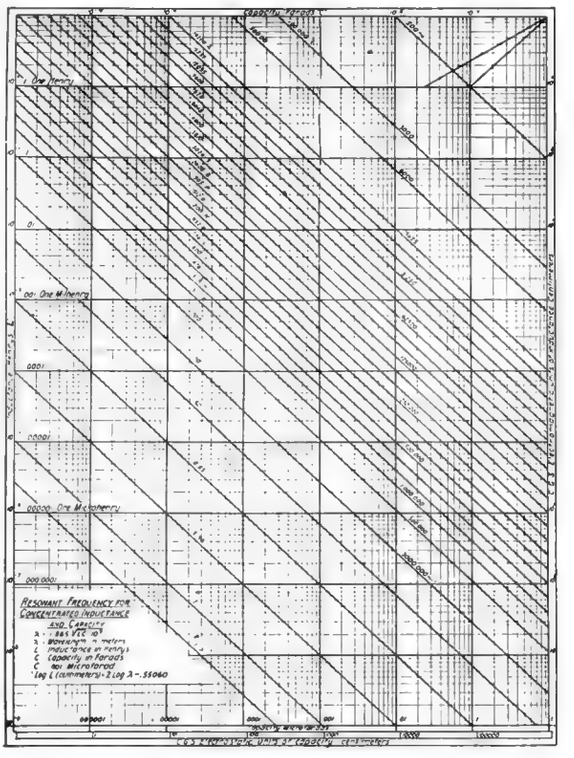
The following description is partly for the object of assisting the amateur to construct his own graphs to a larger scale after similar methods to those here employed in constructing the present chart.

The scale at the top covers the range 10^{12} to 10^6 farads and at the bottom are the corresponding values in micro-farads, the practical unit of capacity. Just below the micro-farad scale are the equivalent capacities in electro-static units, sometimes employed to express very small capacities. The value 0.001 micro-farad, that of a popular amateur variable condenser, is near the middle of the chart. To the right, values extend to 1.000 times this and to the left to 1/10,000, which is quite small.

It may be noted here that one electro-static unit of capacity is the capacity of a sphere of one centimeter radius, far removed from other conductors. One-thousandth micro-farad is equivalent to 900,000 electro-static units.

The right-hand vertical scale gives the inductance in C. G. S. electro-magnetic units or centimeters and the left-hand scale the corresponding values in practical units or Henrys, exprest both in decimals and exponentially, so that those who only occasionally use such notations will here find the correct equivalents.

The scale starts at the bottom with one centimeter of inductance. The next main division is for 10 centimeters, and from the starting point the following main division is for 100 centimeters. As the scale extends to 10^{10} centimeters or 10^9 times the first main division, which is about one-inch long, it may be quite readily estimated that 10^9 inches is equivalent to nearly 16,000 miles, illustrating the enormous range covered.



Here's the Radio Computation Chart You Have Been Looking For. Solves Your Inductance, Capacity and Wave Length Problems Instantly. Larger Printed Proof of Chart, 7¼ by 10 Inches, Sent Free Upon Request. Blue-Print of Chart Measuring 19 by 25 Sent Postpaid on Receipt of 25 Cents to Interested Readers.

The small subdivisions of the scales must necessarily follow the same law as the main divisions and for convenience, their values, which may be obtained from any table of common logarithms, are here given as a percentage of the main divisions.

1	0.00	6	77.81
2	30.10	7	84.51
3	47.71	8	90.30
4	60.20	9	95.42
5	69.89	10	100.00

If smaller subdivisions are desired for greater accuracy they may be obtained from logarithmic tables.

A convenient graphical method of making the subdivisions is by means of a slide-rule scale. Drawn from the upper right-hand corner the longer line is made equal to the 1 to 10 scale of a slide-rule and the horizontal lines are drawn thru the unit divisions of the rule. By transferring the lengths from the slide-rule with a pair of sharp dividers quite accurate scales may be constructed. The vertical subdivisions are then drawn thru the intersections of the horizontal subdivisions and the resulting diagonal of the upper right-hand rectangle.

If the work is accurately done, long straight lines in any direction will intersect neatly the corners of the main rectangles.

Now note this property of the double rectangular logarithmic scales so produced: If a straight diagonal line is drawn thru the corners of the main divisions from left to right in the downward direction, the product of the values of the vertical and horizontal lines at the intersections is constant. This may be noted by inspection. The same is true for any other parallel line and the logarithmic subdivisions.

Now, for a constant resonant frequency, the product of the values of capacity and inductance must be constant. Therefore for any constant value of this product the frequency is constant and is a *straight line relation* to the scales, which is much simpler than a curved line relation.

The graph is so simple that it may be easily expanded to any extent in any direction or any given section may be enlarged to any extent if greater range or accuracy is desired.

Having constructed the scales for capacity and inductance it remains to draw in the diagonal lines for frequency or wave length.

This may be done from the familiar formula:

$$\lambda \text{ (wave length in meters)} = 1.885 \sqrt{L(\text{Henrys}) \times C(\text{Farads}) \times 10^9}$$

which changed to the logarithmic form, for convenience in calculations, and making $C = 0.000000001$ farad or 0.001 microfarad and expressing the inductance in centimeters so as to avoid small decimals we have:

$$\log L \text{ (centimeters)} = 2 \log \lambda \text{ (meters)} - 0.5506$$

In order not to complicate the graph too much, only a few frequency and wave length lines are drawn. The lettered wave lengths used by the U. S. Navy are included. The amateur may easily add lines for any desired wave length.

The relation between the Navy wave lengths are as 1:

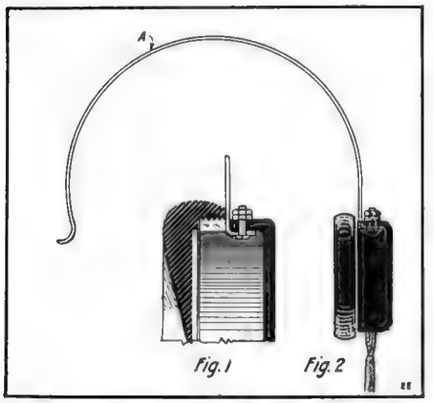
$$\sqrt[3]{2} : \sqrt[3]{4} \text{ or as } 1 : 1.25992 : 1.58740.$$

The calculated values of the wave lengths shown and the inductance in centimeters at 0.001 micro-farad are as follows:

Wave Length Meters	Frequency Cycles Per Second	Inductance Centimeters	Log Inductance
2	150,000,000	1.125	.0515
5.96	50,400,000	10	1
18.85	15,900,000	100	2
50	6,000,000	703.6	2.8473
100	3,000,000	2,814	3.4494
200	1,500,000	11,250	4.0515
300	1,000,000	25,300	4.4036
378	794,000	40,210	4.6043
476	631,000	63,820	4.8050
600	500,000	101,300	5.0057
756	397,000	160,800	5.2064
952	315,000	255,300	5.4071
1,200	250,000	405,300	5.6078
1,512	198,000	643,300	5.8084
1,905	157,500	1,021,000	6.0091
2,400	125,000	1,621,000	6.2098
3,024	99,200	2,573,000	6.4106
3,810	78,800	4,085,000	6.6112
4,800	62,500	6,484,000	6 8119
6,048	49,700	10,300,000	7.0126
7,620	39,400	16,340,000	7.2133
9,600	31,250	25,940,000	7.4139
12,095	24,800	41,180,000	7.6146
15,239	19,700	Henrys	7.8154
19,200	15,600	.104	8.0160
50,000	6,000	.704	8.8473
100,000	3,000	2.815	9.4494
600,000	500	101.3	11.0057

CLOCK-SPRING HEAD BAND.

In the ordinary watch-case receiver the loop for hanging on the hook is placed as in Fig. 1. An idea occurred to me thru an accident which happened to the receiver I was examining. I dropt it, breaking the



This Home-Made Head-Band Constructed from a Piece of Old Clock Spring Proves Efficacious in an Emergency.

loop off. When I picked it up I noticed the placement of the loop and an idea came to me. I thought of getting a clock spring ⅜-inch wide and bending it and placing it in as the loop had been and so forming a head band. I procured an old clock spring from a discarded clock and bent it to fit my head. I then bent it as in Fig. 1 to fit the hole in the receiver. I put the spring into place and put the piece of rubber back, and heating a large nail I ran it over the cracks left between the piece and the receiver. I then emeried the surface until it was smooth. In this way a fair head-band can be made for and by the amateur.

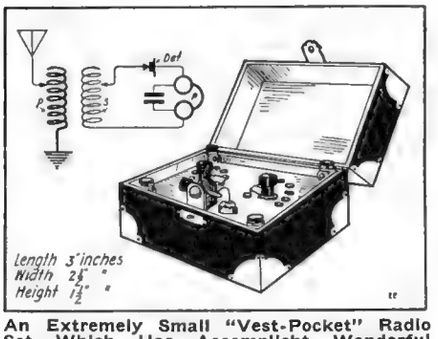
Bending the free end of the spring out as at Fig. 2 will avoid scratching the face.

Contributed by FRED ELLENBERGER.

A "VEST POCKET" RADIO SET.

I give herewith a sketch and details of a small pocket receiving set. I know that many of your readers would like to make one. I have tried mine out on the big antenna at NAH, where I am an operator, and found that I can get quite a range of wave-lengths on it. The secondary is wound with No. 32; the primary with No. 36, silk-covered magnet wire, 20 turns to a contact; 10 contacts to both secondary and primary. A fixt condenser is shunted across the 'phone terminals; it is made of thin tin-foil, about sixteen square inches, wrapt in waxed paper. The detector is galena. All parts are nickel plated and mounted on hard rubber. The coupling is fixt. QST from NAA could be heard faintly. Waves from 300 to 1,200 could be heard good.

Contributed by
AUDLEY V. H. WALSH.



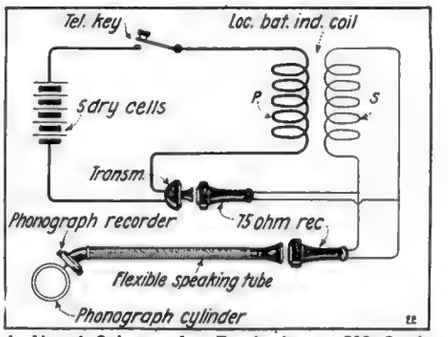
An Extremely Small "Vest-Pocket" Radio Set Which Has Accomplisht Wonderful Results.

UNIQUE SCHEME FOR LEARNING THE CODE.

The writer some time ago decided to learn the code, and it occurred to him that as he had an "I. C. S." language phonograph, it might be used to advantage in this connection. At first a buzzer and telegraph key were rigged up, the recorder and a blank record was placed on the machine, and a few dots and dashes were recorded. When reproduced, the results were not entirely satisfactory as the sounds were rather weak and ragged. Then the following scheme was tried out and the results were good clear tones somewhat similar to a 500 cycle station.

A telegraph key, five dry cells, the primary of a local battery induction coil and a telephone transmitter were connected in series. Two 75 ohm bi-polar receivers were connected in multiple, across the secondary of the induction coil. One of these receivers was supported so as to face the transmitter and be tight up against the mouth-piece. This produced the ordinary well-known "howler" effect, whenever the telegraph key was closed.

One of my indulgent commercial telegraph operator friends having become interested, volunteered to make me some records. The phonograph was adjusted to a speed of about 100 R.P.M., a blank record put on and the second receiver held in front of the speaking tube of the phonograph, while my friend tapt off the Continental code, running thru the alphabet at the rate of about 8 to 10 words per minute and repeating each letter four times. Next some reading matter was recorded on another record at a slow rate of speed. When



A Novel Scheme for Producing a 500 Cycle Tone by the Reaction Between a Microphone and a Receiver for Recording Code Practise Signals on a Phonograph.

the reproducer and horn were placed on the machine and the records run off, they turned out excellent and could be read anywhere in the room.

A few records made in this manner act as a constant guide to the beginner and enable him to rapidly learn what good signals should be like, assuming of course, that the records were made by a good operator.

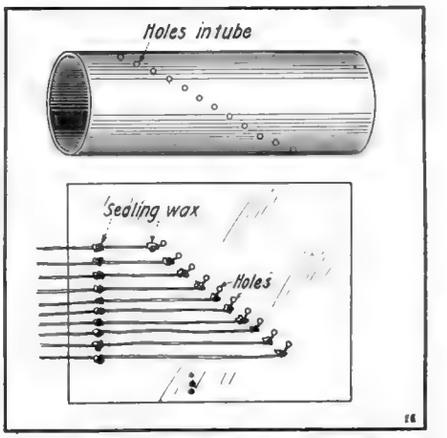
Contributed by L. A. GARY.

HINTS ON SECONDARY TAP LEADS.

In making taps from the secondary of a loose coupler or on a primary switch, many readers undoubtedly have a great deal of trouble. A little wrinkle which I found, eliminates all the bother caused by these taps. First the taps should be taken thru the tube in the manner shown in the illustration.

After the wire is past thru the tube, apply a small speck of sealing wax, a little away from the hole thru which the tap is brought. A little more wax is placed on the wire after it has been straightened, near the ends, which will contain the switch. By this method there are no loose wires in the secondary, and therefore none liable to cross or get tangled with the support rods.

Contributed by
ALBERT W. WILSDON.



A Clever Way In Which to Secure and Bring Out the Tap Leads On the Inside of Loose Coupler Secondaries. They Are Fastened In Place With Sealing Wax.

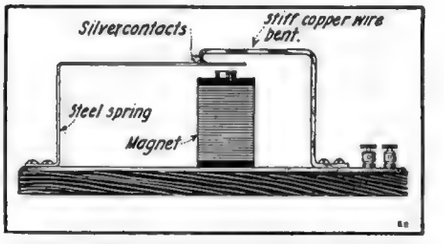
A MINIATURE RADIO BUZZER.

The base of the buzzer should be made of some tough wood or fiber, the dimensions being left mostly to the maker. The single electro-magnet core consists of a soft iron rivet or brad similar to boiler rivets, but much smaller, the one needed here being about ⅜-inch in diameter and 1 inch in length. A hole is bored in the base and the rivet forced thru with the head set flush with the under side, as shown. Wind the projecting end of the core with at least four layers of No. 30 B. & S. silk-covered wire. Now, connect the ends of the coil to two consecutive binding posts, three having been erected as near the edge of the base as possible.

The armature or vibrator is made of a corset spring or something similar. The corset spring must be heated to a cherry red and then bent into the desired shape. Bend the spring as shown, so that it will stay about ⅛-inch above the magnet when mounted as shown. A hole is then punched in the spring and a short piece of silver wire riveted into it. This is one contact point. A wire is now led from the armature to the remaining binding post.

The current is conveyed to the armature thru a stiff copper wire bent double and hammered together at the contact. It has a piece of silver wire or platinum soldered to it at the contact point. This wire is connected to the middle binding post and then bent over so as to barely touch the contact on the armature.

This buzzer could no doubt be reduced in size until the hand could be closed over it; yet it does its work as well as one twice or three times as large, and it can be used



A Useful Radio Buzzer of Small Size Which Any "Bug" Can Make for a Few Cents, and in a Few Minutes' Time.

to an advantage in a portable wireless set or for learning the code, et cetera.

Contributed by HAROLD LEWIS.

A Simple Hand Milling Machine

By THOMAS REED

HONEST, I'm sorry about that "Arabian alarm-clock," Bugs. I know you were just beginning to feel, whenever you saw my name attached to an article, that you were assured of a sober, dependable ex-

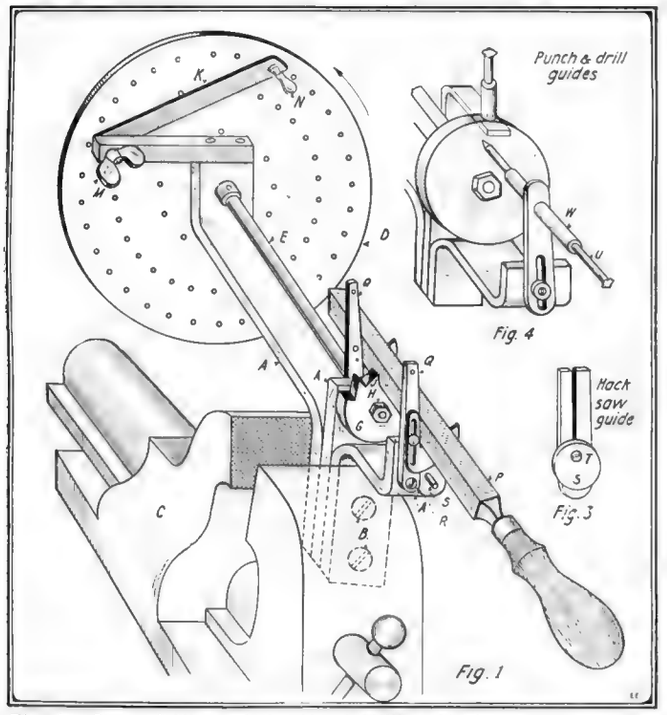


Fig. 1. General View of the Hand Milling Machine Which Every Experimental Machinist Will Want to Build. Not Only Is It An Extremely Serviceable Device, But It Gives the Fundamental Ideas of the Larger Milling Machines. This Device, Altho Quite Simple, Is Capable of a Surprisingly Large Variety of Work.

cient except for the fact that in operation the machine is held firmly in the vise, C, which gives all the stability required.

The soul of the machine is the index-plate, D. This is a disc of thin metal, perforated with rings of small holes; the number of holes being different in each ring, but dividing the circle into equal spaces—60, 72, or whatever the case may be.

The index-plate is fastened immovably to the shaft E, by the nut F; (see Fig. 2) and as the plate and shaft turn, they carry with them the work G, held on by the nut H. Long pieces of work can be steadied by the back-center S.

While the work is being operated on—say while the ratchet-tooth J is being filed out—the index-plate is held in a fixt position by the spring-lever K; a peg, L, on the end of which, enters one of the holes in the plate. The lever, with its peg, is placed in line with any of the circles of holes by loosening the wing-nut M, on the bolt of which the lever K is pivoted.

The ratchet-tooth J correctly, is sure to "come out right."

The holes in the index plate should be spaced off and drilled as accurately as possible, but errors tend to eliminate themselves, from the fact that the diameter of the index-plate is so much greater than that of the work. If you drill the plate anything like near enough to satisfy you, you will be surprised at the apparently perfect regularity of the work.

It is best to make the index plate from 1/16 inch-stock, but thin sheet iron will do. If we must (which is my delight) draw on our household resources, I should think the bottom of a tomato-can, carefully unsoldered by rotating over a gas-flame, would make an excellent plate. And don't forget the invaluable pie tin.

The guides, Q, Q, which hold the file P, should of course, be made out of steel, *and hardened*. The pivots R, R, are eccentric with the shaft E, so that the file may approach the work at different angles.

Fig. 3 shows a hack-saw guide. The disc turns eccentrically at T, forming a variable bottom-stop for the saw.

Fig. 4 shows two forms of punch-guide, where pegs are desired to be set at regular intervals, as in making rotary spark-gaps. After marking the work, the punch U can be withdrawn from the sleeve W, and the hole drilled with a hand-drill. This peg-setting is illustrated in Figs. 9 and 13.

Of the various forms shown in Figs. 5 to 13, Fig. 5 is done by a drill and hack-saw; Fig. 6 by two hack-saw blades in the same handle; Fig. 7 by a knife-file, Fig. 8 by a flat file, Fig. 10 by a half-round, Fig. 11 by very small flat file, and Fig. 12 by a round file. Among the many-shaped files, and one or more hack-saw blades, you ought to come pretty near producing any figure

position of demonstrated fact; and that fake bing-clock must have jolted your confidence worse than it did the "Sheik's" slumbers.

Well, to commence the long, up-hill fight to regain my reputation as a purveyor of "Frozen Truth" exclusively, I'll present you with a little hand milling machine, designed so you can make it yourselves, for the production of milled objects, such as those in Figs. 5 to 13.

The germ of this idea was a machine which our crowd made years ago, following one said to be used by the old Swiss hand watchmakers. That tool, however, employed a revolving cutter, and, you had to make a separate cutter for each piece of work. The present, greatly simplified machine makes use of files of various shapes, hack-saws, drills, etc., requiring only a special guide for each class of tool.

Referring to Figs. 1 and 2, the frame, A, A, A, would, in a manufactured article, be a casting; but I have designed it from 3 pieces of heavy flat wrought-iron, bent into shape and held together by the screws B, B. These screws would probably not be sufficient being finished, it is desired to rotate the work into position for the next tooth. Say you are cutting a 30-tooth wheel, and your outer index circle contains 60 holes. By pulling on the small handle N, the spring-lever K bends, and the peg L is withdrawn from the hole. Be careful now, and don't lose your place. Rotate the index-plate in the direction of the arrow, count off two holes, and let the peg slip back into the second hole. Now your work is held for the next cut just 1/30 of a revolution ahead, and so on around your ratchet-wheel, which, if you count

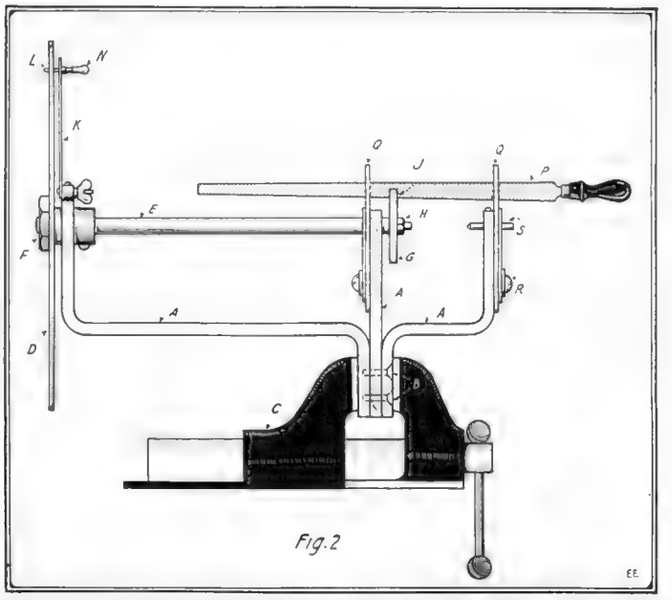
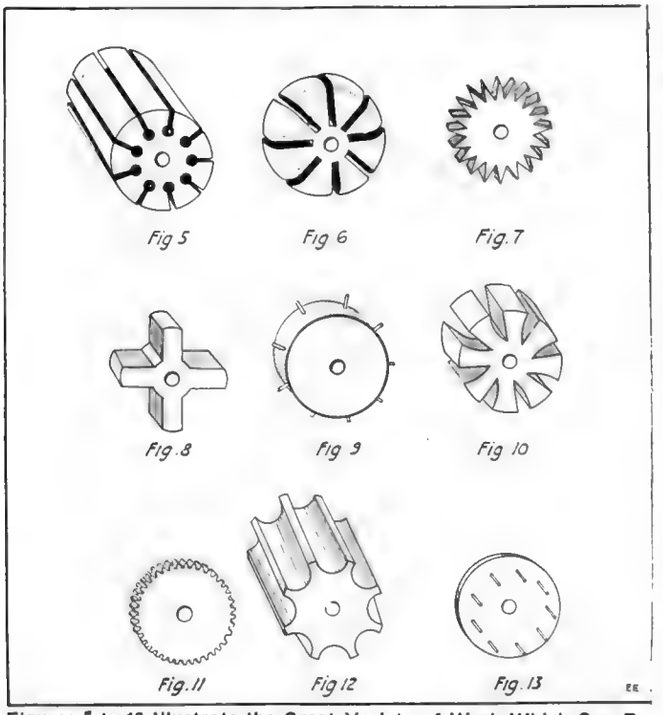


Fig. 2. A Side View of the Hand Milling Machine With a File Being Used in the Guides. The Machine Is Held in a Substantial Bench Vise.

that even the wild requirements of a "Bug" may find essential to his happiness!

Oh,—as the numbers of the holes in the index-plate; a ring of 60 holes gives you the following equal divisions: 2, 3, 4, 5, 6, 10, 12, 15, 20 and 30. Another ring of 56 holes would give you 7, 8, 14, and 28. This covers most of the desirable low numbers, and shows how easily you can figure for yourselves any other factors you need.



Figures 5 to 13 Illustrate the Great Variety of Work Which Can Be Turned Out on the Hand-Milling Machine Here Illustrated and Described. This Is, However, Only a Partial Number of the Different Shaped Parts Which Can Be Made With the Aid of This Hand-Miller, and With a Little Ingenuity on the Part of the Building Machinist, Many Other Useful and Intricate Parts Can Be Conceived and Executed.

THE PRODUCTION OF RADIUM FROM U. S. CARNOTITE ORES.

As one of the results of an agreement between the National Radium Institute and the Bureau of Mines, Department of the Interior, to develop a more efficient process for the manufacture of radium out of the carnotite ores of Colorado and Utah, the Bureau of Mines now has as its share more than $180,000 worth of radium for use in the sciences. This was procured for an expenditure of less than $38,000. In addition, under the agreement, the bureau has turned over to the National Radium Institute about 6½ grams of radium, and has given the country a method of producing pure radium compound from the ore for one-third the current price of radium.

When the Bureau of Mines began this work in 1912, it found that the precious carnotite ore, constituting the largest known supply of radium ore in the world, was going to Europe, mainly to Germany, where it was being turned into radium and sold back to the United States at fabulous prices.

AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

A MERCURY FIRE ALARM.

Here is a drawing and a description of an automatic fire alarm which I believe will be of interest to your readers.

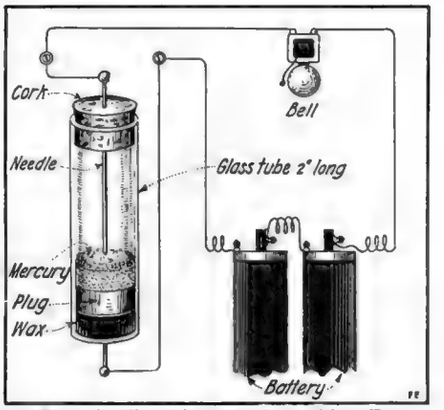
The device makes use of the expansion of mercury when heated. It can be quickly adjusted and requires no re-setting. The fire detecting mechanism is clearly shown in figure.

It consists first of a glass (or brass) tube about 2" long and having a bore of ⅛" or a trifle more. The lower electrode has a short piece of copper wire soldered to it 4" long. The rod is fitted into the tube as shown and then the end of the tube is filled with the sealing wax. The rod should not fit too tight or its expansion will break the tube.

A small rubber cork that fits the tube tightly has a needle run thru it to form the upper electrode. A short length of wire should be soldered to this needle as shown in the drawing.

The tube is fastened to the base, measuring 1½" by 3" by means of a brass strip and two small screws. Binding posts are mounted on the same base and the wires connected to them.

A few drops of mercury are put in the tube and the rubber cork and the needle inserted as shown in figure. By regulating the distance between the needle and the surface of the mercury, the temperature at which the alarm is given can be regulated.



An Electric Fire Alarm Is Something Everyone Will Want to Experiment With. Here's a Home-made One Which Can Be Constructed in Dozen Lots at Very Small Cost.

A good method of adjusting this apparatus is to connect a bell and battery to the terminals. Place the instrument and the thermometer in an oven or a sand bath and adjust the needle so the bell just rings when the thermometer registers 110 degrees Fahrenheit.

With such a system an annunciator may be used to indicate from where the alarm came.

This device has been used by the writer for the past two years with success.

Contributed by WALTER L. MILLER.

KEEP YOUR STRAW HAT ON TO AVOID SHOCKS.

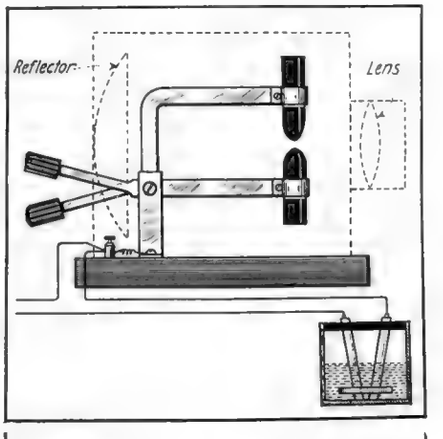
An engineer suggests in a recent issue of *Safety First* the wearing of straw hats with stiff brims for those employed around electrical stations. It seems that the straw hat is far superior to a felt hat from the safety standpoint; for should the head come accidentally in contact with live wires, the rim of the hat or the crown prevents injury, and gives the necessary warning. The same holds good when working around steam pipes. In a recent accident, where a man unconsciously came in contact with a 13,000-volt line, he would have been protected had he worn a straw instead of a felt hat.

The singing of telegraph wires is sometimes regarded as a weather prognostic, though opinions differ as to the kind of weather it foretells. There has been much discussion as to the cause of this sound. Probably it is simply the Aeolian harp effect, and its occurrence depends chiefly upon the direction of the wind in relation to the direction in which the wires run. Variations in the pitch of the sound depend upon changes in the tension of the wires with varying temperature. Electricity, contrary to popular belief, has absolutely nothing to do with the singing.

A SIMPLE BUT POWERFUL HAND-FED ARC-LIGHT.

The arc-light shown can be made from odds and ends at a very small cost and can be used for wide variety of purposes. A piece of wood for the base, some strips of brass, a few battery binding posts, screws, drop cord and plug, and two battery carbons in a fruit jar, with a small piece of fiber insulation are all the articles needed to construct the arc. The fruit-jar resistance is one novel feature. Two ordinary battery carbons are held at a fixt distance from each other by two strips of fiber, the bottoms being about ⅛ of an inch and the tops about ½ of an inch apart. Rubber insulation cut from an old tire may be used for handles at the end of the strips holding the arc carbons. By moving these handles the arc may be raised or lowered or fed together. After the wiring is completed fill jar ¾ full of water, add a little salt, and connect the plug with a regular 110 volt house light socket. This will make it necessary to put heavier fuses in the fuse block. This arc will melt any substance placed between the carbons, as it will give from ¼ to 1" flame. If a housing is placed over the base, as shown in dotted lines, and a reflector used with a common reading glass in the sleeve, the arc will cast a powerful beam for a distance of a mile.

Contributed by CARLYLE WALTS.



Easily Made Form of Electric Arc-Light Suitable for Use in Stereoptican or Home "Movie" Machine.

The Manipulation of Glass Tubing in the Experimental Laboratory

By Prof. HERBERT E. METCALF

PART I.

IN the experimental laboratory there is always a demand for small pieces of apparatus which are made out of glass, and yet are usually too high in price to be purchased on the market. Again,

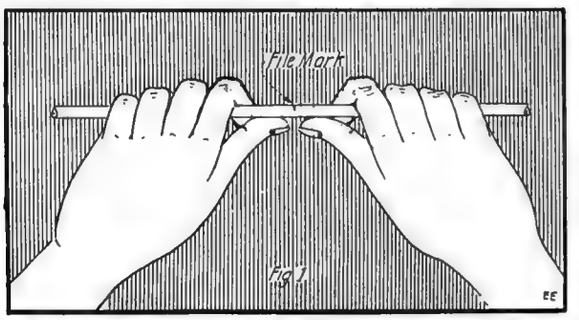


Fig. 1. This Shows How, After Making a File Mark on a Piece of Glass Tubing, It is Broken By Grasping the Tube at Both Ends, One on Each Side of the Cut With the Thumbs Placed Directly Opposite the Cut. You Then Push "Outwards" With the Thumbs and a Square, Clean Break Will Invariably Result.

while the apparatus may look simple to make, most all experimenters, after breaking enough glass to nearly pay for the finished article, give up the job in disgust and worry along without the apparatus. But if they had a little knowledge of simple glass-blowing they would save many dollars, and enrich their laboratories with many pieces of apparatus not otherwise obtainable.

In the first place the manufacture of small articles out of glass tubing is not hard; in fact, with the proper glass, the proper heating agents, and a little patience, nearly every commercial article made from glass may be functionally duplicated. You will notice that I have said "functionally" because often it is not possible nor at all necessary to duplicate the article. Its function is the standard, and if the home-made machine will do as good work, that is all that is necessary.

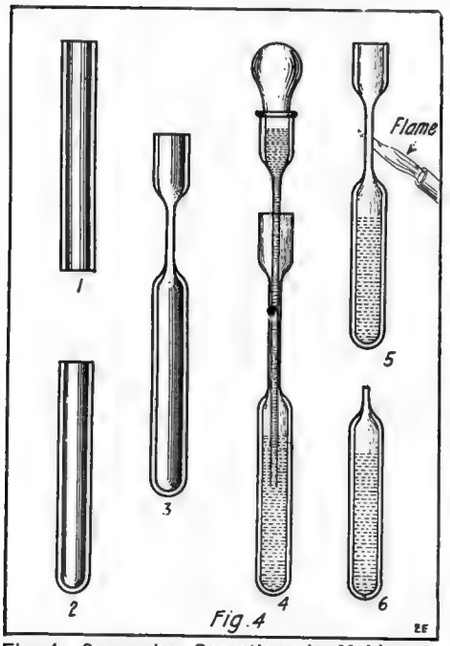


Fig. 4. Successive Operations in Making a Glass "Ampoule"; 2, One End Closed; 3, Tube Drawn Out; 4, Filling; 5. Sealing; and 6, the Finished "Ampoule."

THE KIND OF GLASS TUBING TO USE.

To begin with, the glass tubing MUST be fresh. The experimenter cannot expect good results from glass tubing which has been lying around his laboratory since the year one. That is why such poor success is attendant upon many efforts in this direction. He will have to go directly to the largest supply house in his city and demand *fresh soft glass tubing* suitable for bending. To get *hard glass* such as *boiler glass* tubing will spell failure immediately. If there is no supply house close at hand then write an order to the nearest large supply house, in all cases specifying explicitly that the tubing is to be fresh soft glass to be used in the flame. In no case should tubing be obtained from the local hardware store, as it will probably be many years old. All this is extremely important because the entire success of all future operations will depend upon the quality of the glass. Glass tubing becomes brittle with age, and a piece of tubing much over a year old is very apt to crack no matter how carefully heat is applied.

EQUIPMENT NEEDED FOR THE MANIPULATION OF GLASS TUBING.

For simple bends in tubing an ordinary Bunsen burner is needed, provided it be equipt with a *fish-tail tip*. In fact, all work which does not need fusion may be done with a burner of this kind.

For more complicated work which *does* require the fusion of glass, an air blast must be added to the flame in order to obtain the high degree of heat necessary for the proper joining of the glass. This may be simply a small tube held in the mouth. By blowing air thru a yellow flame a fairly good blast burner may be had, but is not very satisfactory because a steady blow cannot be maintained, nor can the size of the flame be suitably regulated. The most practical thing to do is to buy, new or second-hand, an adjustable flame blast lamp. The air supply may be obtained in several ways; from a pump, foot blower, or a water jet air pump, of the type described elsewhere in this issue.

An asbestos mat such as used on the table may be obtained at any hardware store, and is needed to lay the hot glass on while it is cooling. Hot glass must NEVER be laid on metal to cool, and as it will burn other materials this mat is indispensible.

The blast lamp must be placed on the experimenter's table with the flame directed away from him and with the mat on his right, so that he will be able to use both hands on the glass tubing, and then place the finished product on the mat to cool. Fingers are better that pincers of any kind and a pair of kid gloves will save the hands from many a sharp burn. A supply of small corks to fit all sizes of tubing may be obtained from a supply house or may be whittled out of drugstore corks. These are very important in nearly all operations and may be used over and over again. Several feet of rubber tubing of various sizes, a generous stick of sealing wax, and a sharp three-cornered file fits us out.

Now that we have assembled before us all our materials; the glass tubing of the

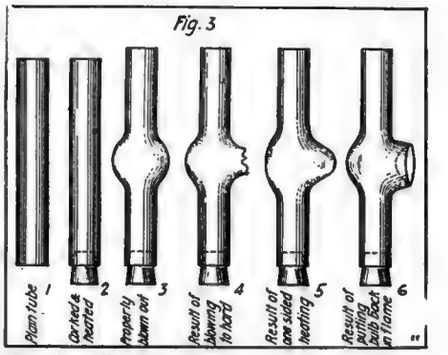


Fig. 3. This Illustration Shows the Various Stages Gone Thru in Heating a Glass Tube for the Purpose of Enlarging It at a Given Point.

diameter required, the burner in its proper position connected to its gas and air supply, the asbestos mat and the corks where they may easily be gotten at; we will take up the file and proceed to the first operation, cutting the tubing to its proper length.

The following operations should be very carefully read over before being performed, even going so far as to rehearse before hand, because there is nothing so discouraging as to sneak a look at the printed directions in the middle of an operation, and then returning to work only to find that the glass had cooled off while you were reading. It should have been kept hot, and when the flame played on it again it cracked.

CUTTING GLASS TUBING.

Glass tubing up to one-half inch in diameter may be cut with a sharp three-cornered file. Place the tubing in front of you and make a single deep cut in the tube at the proper length, and then break it by grasping the tube in both hands, one on each

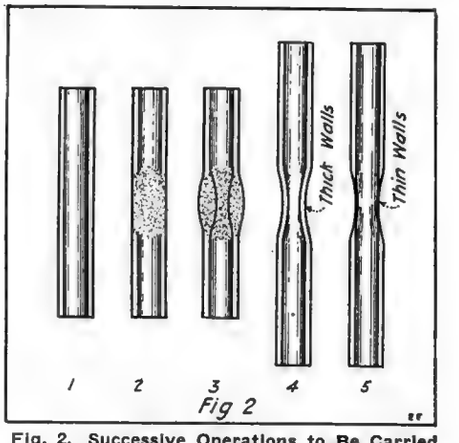


Fig. 2. Successive Operations to Be Carried Out in Heating a Glass Tube for the Purpose of Forming a Constriction.

side of the cut, with the thumbs meeting directly opposite the cut, see Fig. 1. Then push *outwards* with the thumbs, and a square clean break will result. In case one end is short, wrap your handkerchief

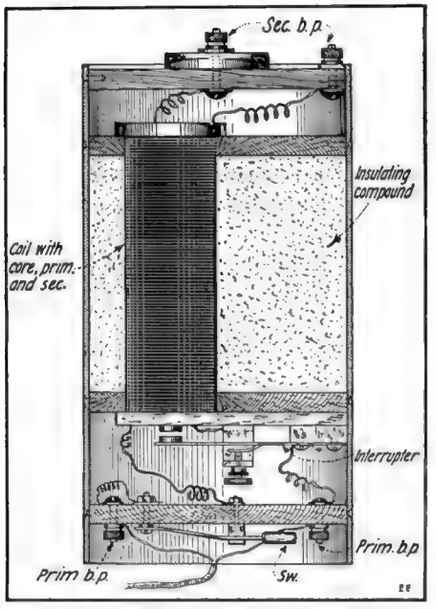
(*Continued on page* 340)

TRICK "SHOCKING BATTERY."

A "shocking battery" represents a novel departure from the ordinary shocking coil, and is nothing more or less than just such a coil, enclosed in a case so that it closely resembles an ordinary dry cell. How to make it: First turn down a wooden block to 2¾" diameter and ¼" thick. Leave a small extension ⅛" thick and 1" diameter on one side, to resemble the carbon rod of a dry cell. Drill holes for the binding posts and cut four small slots at the edge 90° apart for the battery supports. When finished paint the block black and place in the binding posts. It should now closely resemble the top of a dry cell. Cut two blocks to 2¾" diameter and ¼" thick. Drill a hole large enough to accommodate the coil to be used in the battery. Do not drill it directly in the center but off to one side so as to give ample room for the vibrator.

The coil to be used may be an old shocking or "medical" coil, a telephone induction coil or one may be made for this purpose.

Another block is now turned down to 2¾" diameter and ¼" thick and properly notched for the supports. On this block is mounted a small single-pole, single-throw



Place This "Special" Dry Cell With Several Others and Ask Your Friends to Connect Up All the Cells in Series, etc. At the Pyschological Moment Let 'Em Have the Full Shocking Coil Current By Closing the Switch. They'll Swear It Was "Static!"

side-action switch and two binding posts for the primary. The complete battery is now assembled, connections being made and parts fastened together by the battery supports which are wooden strips 6" long and fit into the notches provided for them. The battery is now rapt up in some cardboard or heavy paper. It would be well to fill in the space around the coil with some insulating compound to increase the insulation. The whole is now placed in a sheet metal container fastened to the same with screws which is in turn placed in an old battery carton that has the bottom knocked out. A concealed flexible lead is now connected to the primary binding posts and the "battery" is ready for action. It may be operated by a flashlight battery concealed in the case with the coil. Initiate your electrical friends by having this "battery" on the table beside several other regular cells. Then tell them you will bet they cannot connect up the cells properly, in series, parallel, etc. Let 'em have it, when they get to making the connections.

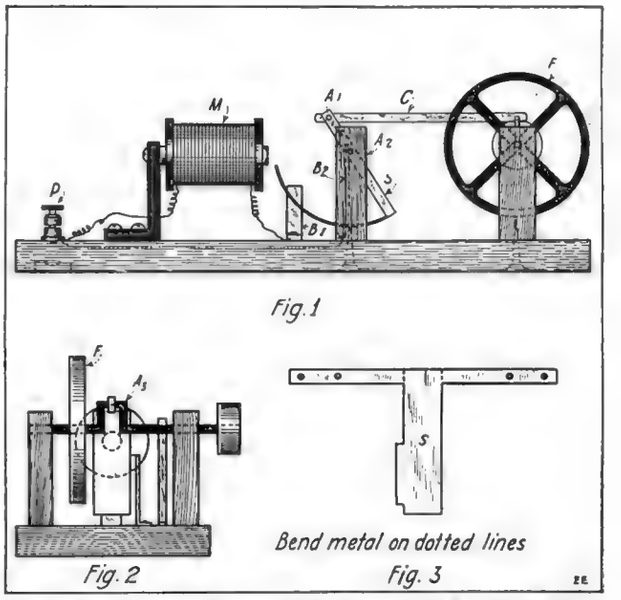
Contributed by L. SVOBODA.

A NOVEL ELECTRIC ENGINE.

In Fig. 1 of the illustration is shown the side view; in Fig 2, the end view; while the cut Fig. 3, gives the working details of armature "S." The connections are shown in Fig. 1. In reference to the lettering of the illustration PP^1 are two binding posts, next a brass support for M an ordinary electro-magnet, B^1 is a copper or phosphor bronze brush which makes contact with the projection on S. A sheet-iron swing S, is made after the model in Fig. 3. It swings on the axle A^2. B^2 is a brush making contact with A^2. A^1 is a shaft which joins the connecting rod C to the swing S. A^3 is a camshaft to which it fastened the fly-wheel F, and a small pulley. Dimensions can be made to suit the constructor.

I have used this motor for some time and have found it satisfactory in every respect.

Contributed by PAUL NACHEMSON.



One of the Simplest Designs of a Miniature Electric Engine Possible. The Curved Iron Armature is Successively Drawn Forward By the Electro-Magnet and Released. By a Crank Motion the Wheel is Set Spinning Rapidly.

HOW TO "STEEL-PLATE" PARTS.

"How automobile parts and all sorts of machinery are steel-plated" should be an interesting topic to the readers of the "E.E."

Purchase some Potassium Ferricyanid in a drug store or other chemical house. Great care must be taken in handling this chemical compound as it is one of the most deadly poisons. To show its fatal effects, one can perform the following experiment. Drop a small piece of this compound into an old forlorn cat's mouth. Immediately its head begins to droop and then the cat stretches itself out and dies.

Dissolve some of this Potassium Ferricyanid in water. Then put in the iron to be *steel-plated*. This should be left in the solution for about 48 hours. After the iron is taken out it is heated in a furnace or even a stove for a short while. Then a steel coating is permeated into the iron.

From the chemical standpoint the action is a very easy matter to explain: After the iron is taken out of the Ferricyanid it has a practically pure coating of iron. Then when it is placed in a furnace, the carbon escaping from the coal, unites with the pure iron coating to form steel.

This is used a great deal in auto parts manufacturing.

Contributed by A. MENCHER.

HOW TO MAKE A SMALL COMMUTATOR.

Procure a piece of brass tubing the diameter and length you wish your commutator. Flush pipe used by plumbers is very good for this purpose. It comes in sizes from ¾" inside diameter up to 2" and is seamless and uniform. Square up the ends in a lathe if one is handy, or, if not, a fine file and try square will serve. Then set the dividers and scratch lines around the tube from 3/16" to ¼" wide, depending upon the diameter. Space off the tube into as many segments as there are slots in the armature, and, with a scriber mark the sections where they are to be divided. Use a fine hack saw, or a piece of clock spring held on edge in the vise and hacked with a sharp edge file. This makes an ideal saw for the purpose. Saw along the dividing lines from each end until you reach the lines A-A, as in Fig. 1.

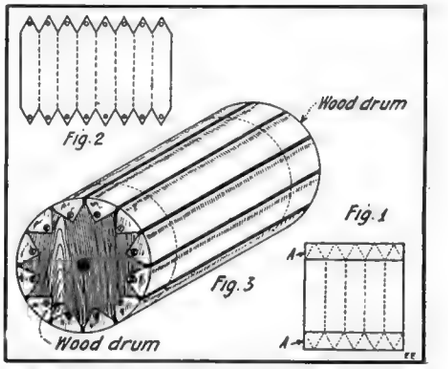
After all the slots are sawed take a saw-file and file down each until the tube has the appearance of Fig. 2. Next turn up a hardwood or fiber plug that will fit snugly inside of the metal tube. Shellac it and insert into tube, being careful that the plug is not longer than the distance of the tube from the bottom of the "V" notches.

Bend the ends over as shown in Fig. 3 and drill or punch a small hole in the end of each segment on each end of the commutator. Use small escutcheon pins to nail the ends down tight against the wood. Now hold in the vise and saw the segments apart as indicated by dotted lines Figs. 1 and 2. It is optional, but if you wish, you may saw down into the wood ⅛" beyond the brass tubing and insert firmly a strip of mica held in place by the shellac. The commutator can be filed and sandpapered up smooth afterward. The leads from the armature coils are fastened to their respective segments with solder, using rosin as a flux.

The writer has used this commutator with and without the mica, but advises the use of mica for any current above 50 volts.

Curly maple is the best wood to use for the hub, but fiber is the best of all.

Contributed by HARRY L. ALLEN, JR.



For Small Dynamos and Motors This Quickly Constructed Commutator Will Prove Adaptable. The Brass Sheet is First Marked Off, Then Fastened Around the Drum. Afterward the Segments Are Formed By Cutting Saw Slots in the Manner Indicated.

Experimental Mechanics

By SAMUEL D. COHEN

LESSON VI.

Thread Cutting and Metal Turning

CONSIDERING that the novice has become thoroly familiar with the rudiments of plain " thread cutting" as given in the last lesson, and taking also into consideration that the amateur has become a junior master of

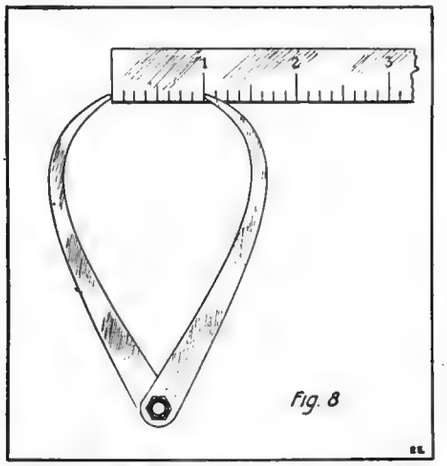


Fig. 8. This Shows How a Pair of "Outside Calipers" Are Set Accurately on a Steel Scale. One Leg of the Caliper Rests Against One End of the Rule. Fine Adjustments Are Made by Gently Tapping Either Caliper Leg on the Lathe or Vise.

handling the shift gear problem, the author will now further discuss the subject.

As the student will remember from the preceding lesson the subject of cutting "V" threads was under discussion and now a second type of thread will be taken up and this is the *square thread.* A very good illustration showing how a square thread looks is given in the first illustration. For cutting such a thread a different type of cutting tool will be required, and in Fig. 2, we see the type of tool necessary for this kind of work. This tool is very similar to a *parting tool,* only that the rake must be provided for in the portion that enters the work to prevent side rubbing, thus destroying the value of an accurate thread. The tool holder as shown simplifies to a great extent the cutting of a square thread. The tool itself is filed up out of a small round piece of tool steel, which is then fixt to the tool post holder by means of a set screw. The tool steel being circular in section, can be turned around in the holder before the set screw is tightened, so as to give any desired degree of rake.

The width of cutting edge of the tool must be equal to half the pitch of the thread. This is evident from the first illustration where "P" shows the pitch of the thread, which is equal to the thickness of a thread and space. The exact width of the cutting tool should be equal to the space R, or exactly equal to one-half of P. For cutting a double or triple thread, the case becomes different as will be seen from the third illustration, which in this case represents a *double thread.* Here the pitch P, is equal to the thickness of two threads and two spaces, so that the width of the cutting tool must be exactly equal to one-quarter of the pitch P. In the fourth drawing is shown a *double thread* screw with only the *first* thread cut. When the second groove is cut in the center of the intervening portions of the work, it results in a double thread.

A very neat way of finishing off a square thread is to drill a small hole into the work at the end of the thread for the tool to run into, as is indicated in Fig. 1. The diameter of the hole should be slightly larger than the thickness of the tool, and the depth a little greater than the depth of the thread. The lathe must be stopt just before the tool reaches the hole, and pulled around by hand for the last turn or so. As soon as the tool finishes its cut, it is withdrawn and run back again in readiness for taking a fresh cut.

In Fig. 5, the student will note the various types of threads that can be cut with the aid of a lathe. It gives a splendid idea as to the kind of work the amateur can carry out with this machine if he once becomes

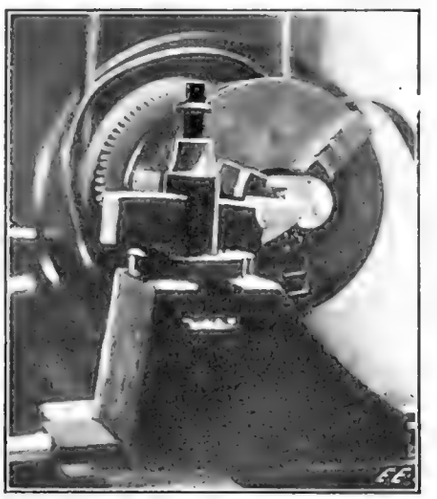


Fig. 9. "Facing Up" the End of a piece of Steel Shaft Held in a Universal Three-Jaw Chuck on the Lathe.

skilled in operating it, and experience is the best teacher.

The procedure in cutting *square threads* is identically the same as for those for cutting "V" threads, with the exception that a different shape of cutting tool is used. It is impossible to cut very fine pitch square threads as the pitch of this form of thread is dependent upon the width of each tooth,

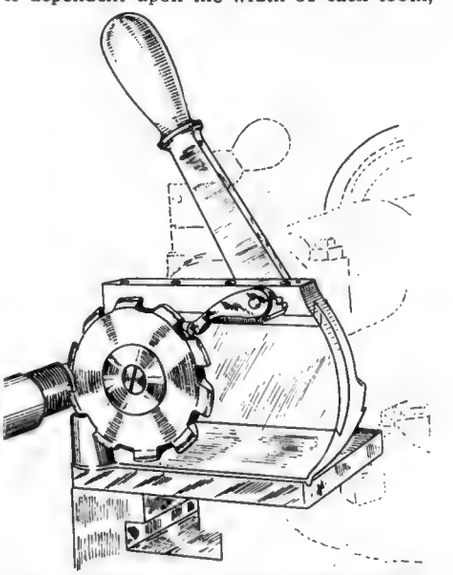


Fig. 7. Appearance of Universal Thread-Cutting Tool Which Carries a Cutting Head Provided With Various Sized Teeth for Cutting Small, Medium and Large Threads. Any Individual Tooth May Be Reground Until Entirely Used Up, Without Changing Its Shape. The Lever Locks the Cutter in Any Desired Position.

which is naturally wide. Square threads are extensively used in machinery where there is a great stress, and where a large motion is desired with a minimum angular movement of the shaft containing the square thread.

The experimental machinist will find of great help a newly devised rotating thread cutting tool, applicable only for cutting "V" threads, and this tool is shown in Fig. 6. Its application to the work is shown in Fig. 7. The tool consists, as will be seen, of a disk of steel having ten distinct teeth on its rim. These teeth are graded for cutting the thread in distinct operations of the tool. The cutter is mounted on a hand slide rest, which is bolted to the ordinary lathe carriage, and the tool is adjusted to each cut by the hand lever as shown in Fig. 7. When fine work such as for taps, etc., is required, the pawl is thrown back out of action, the micrometer adjustment used, and another trip taken across the thread. Advancing the lever one hole in

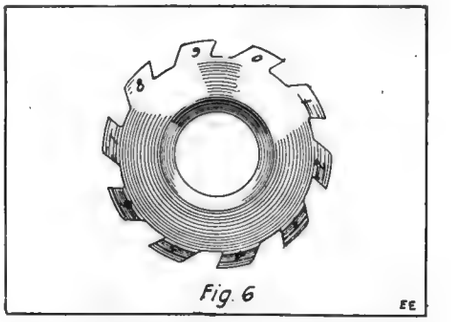


Fig. 6. Cutting Member of Universal Thread-Cutting Tool as Shown in Fig. 7, Above. Each Size of Tooth Is Numbered as Indicated in the Drawing.

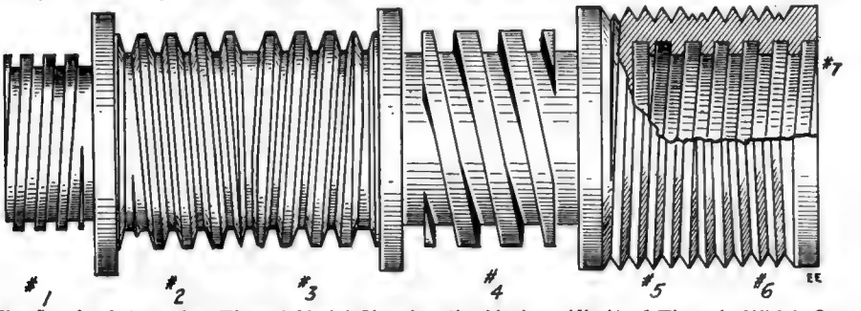


Fig. 5. An Interesting Thread Model Showing the Various Kinds of Threads Which Can Be Cut on an Ordinary Machine Lathe, Including Square Threads, "V" Threads, Internal Square Threads, Et Cetera.

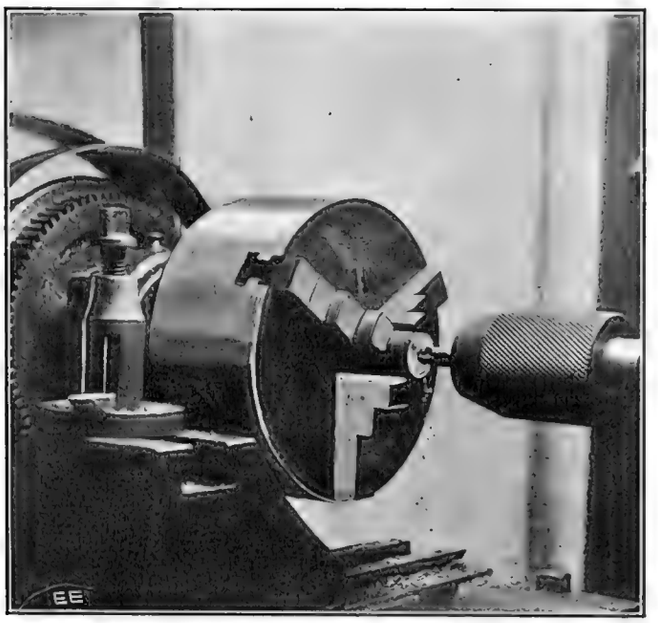


Fig. 10. Illustrating How the End of a Shaft Is Exactly and Quickly Centered By Means of a "Centering Drill" Held In a Hand-Chuck Mounted In the Tail-Stock Spindle of the Lathe. If no Centering Drill Is Available, an Ordinary Twist Drill, Ground to the Proper Angle, Is Used In Many Shops.

Fig. 11. Illustrating the Use of "Precision" Outside Calipers. The Calipers Are First Set on a Steel Scale to the Size Desired on the Finished Work. Never Try to Caliper Stock While Revolving, and Leave a Little Overstock to Be Finished Off With a Fine File, as You Cannot "Turn" the Surface Off Smooth Enough.

the micrometer adjustment, brings the cutting point a fraction of a thousandth of an inch forward. Successive trips with advance of lever will give the finest finish possible to a thread.

The heel of the tooth in action rests upon a stop, so that it can be ground until but an eighth of an inch in thickness, and still retain the full strength and power to do the work. When once set, neither tool nor cross-slide adjustment needs to be changed

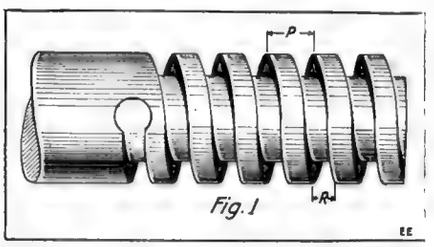


Fig. 1. A Neat Way of Finishing Off a Square Thread As Cut In the Lathe, and Which Method of Ending the Thread Is Carried Out By Drilling a Small Hole Radially Into the Work, at the End of the Thread. This Hole Is Preferably Drilled After Making the First Trial Cut, and It Should Be Slightly Larger Than the Width of the Tool; Also Its Depth Should Be a Little Greater Than the Depth of the Thread.

in cutting the screw or any number of screws in exact duplication. This type of tool requires very little grinding, as the point of the tool is reserved and only used in the finishing or last cut.

METAL TURNING

The author strongly advises the novice to become a thoro master in the making of threads on his lathe as after all, experience will teach him more than a thousand articles

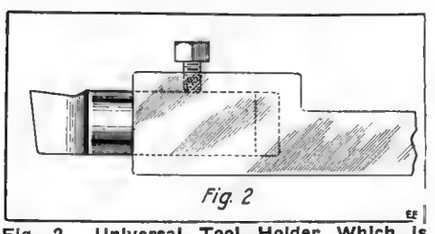


Fig. 2. Universal Tool Holder Which Is Seen In This Case Supporting a Tool for Cutting "Square Threads." The Tool Point Somewhat Resembles the Familiar "Parting Tool."

which he will read on the subject. It was the intended purpose of the last two articles to lead the student of mechanics to obtain a fundamental notion of the subject and allow himself to grasp it thoroly by actual practise. We will now turn our attention to the next important subject, namely, "Metal Turning."

In discussing this topic, let us take a sample at random of round stock of any predetermined diameter, and let the problem of the job be to turn down one-half of the stock to a certain diameter, also having its both ends turned to a certain prescribed length, and one end to have a hole threaded with a certain thread. The first thing to be done with the job is to cut the rod of stock one-quarter to three-eighths of an inch *longer* than the finished length required by the job, so as to provide sufficient material with which to "face off" the ends. Blueprints used for machining operations are marked with a lower case "f" or the word "finish" on all surfaces which are to be machined or accurately finished to size.

Having done this, the next step is to turn down the ends, and care should be exercised to see that the metal taken from each end should not exceed the amount necessary to make the rod of the exact required length. The rod is placed and firmly secured in a scroll or independent jaw chuck on the live spindle, and by means of a left or right hand side-cutting knife, depending upon the position of the chuck, the end is turned down. The amateur will find it worth while to turn to lesson 3, Figs. 7, 8 and 9, to give him proper information relative to these cutting tools. When one side is finished, the work is removed from the chuck and the other side is turned down. In the lathe cut proper precaution should be taken not to take off too much material, as it will reduce the predetermined length. The photograph Fig. 9, clearly illustrates how the piece of work is held in the chuck, and how its end is being "squared up." The next step is to provide centers on each end, so as to secure the work between the live and dead centers of the lathe. This is to be used only when an accurate job is required, and especially when the work is very long. In order to do this, a *center drill* will be necessary, and the work should be secured to the chuck of the live spindle. The center drill is held in a drill chuck secured to the tail stock spindle. Illustration Fig. 10, shows clearly just how this is done. Care should be taken to see that the drill is not fed too quickly or else the drill point may break.

The third step is to place the work between the centers of the lathe, and to secure it to the face plate by means of a *dog*. Fig. 7 of lesson 3, shows how this is accomplished. Before starting to turn the rod, carefully oil the dead center as it will heat considerably when the end of the work revolves upon it, and thus destroy the hardness of

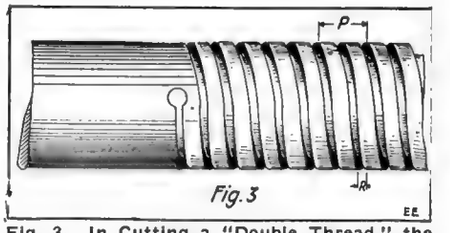


Fig. 3. In Cutting a "Double Thread," the Thread Cutting Tool Must Be Ground to Have a Thickness of One-half That Used for Cutting a Single Thread As Becomes Evident. The Pitch of the Single Thread Is Indicated By P In the Drawing, and Is Equal to the Thickness of Two Threads and Two Spaces. This Makes the Width of the Threading Tool Equal to One-quarter of the Pitch P.

the center. To reduce one-half of the stock to the predetermined diameter, it will be necessary to utilize a diamond-point tool in the slide rest of the lathe, and with the aid of this tool proceed to take the initial cut and run the tool approximately to the center line of the work. Then bring back the tool to the original position, and repeat taking off a certain amount of metal until the

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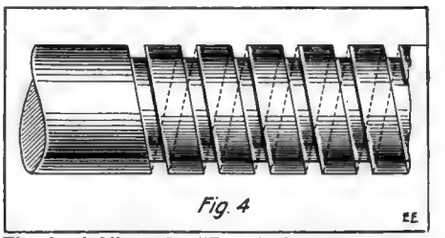


Fig. 4. A View of a "Double Square Thread" Being Cut on Round Stock With Only the First Thread Cut. When the Second Thread Is Turned on the Stock, It Will Come In Between the Convolutions Here Shown, Thus Completing the Double-threaded Screw.

Experimental Chemistry

By ALBERT W. WILSDON

Twenty-Eighth Lesson

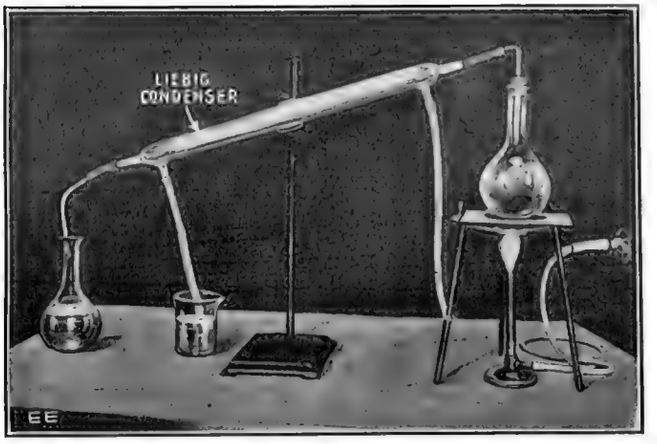


Fig. 129. Apparatus Employed for the Distillation of Water, Which Is One of the Purest Forms and Should Be Used in All Laboratory Experiments. The Larger the Liebig Condenser, the More Water Distilled, and the Greater the Cooling Surface.

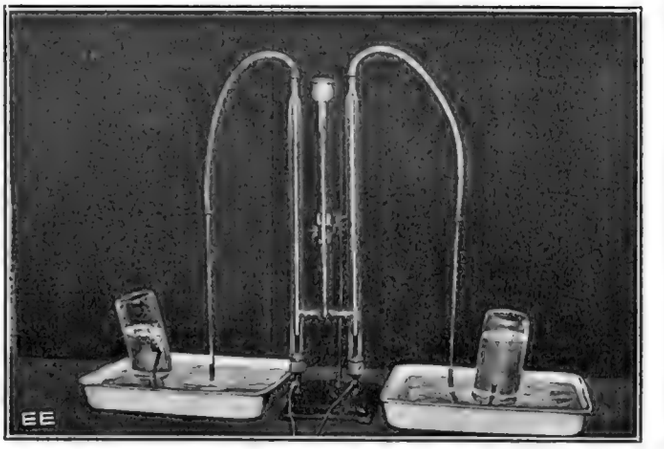


Fig. 130. Electrolytic Generator for Decomposing Water Into Its Constituents, Hydrogen and Oxygen. With This Form, Carbon Electrodes Are Utilized, and May Be Replaced By Copper, Platinum, Silver, Etc., Sealed in Mercury in a Glass Tube. This Type Is Very Efficient.

WATER, HYDROGEN PEROXIDE AND OZONE.

CHLORIDES.

THE chlorides, and especially the chloride of sodium, is universally present in natural waters, being derived both from the dried salt spray in the atmosphere and from the soil. The amount present in perfectly pure water varies enormously, depending largely upon the distance of the locality from the ocean, from saline springs, from beds of rock-salt, and also, in general, upon the nature of the soil. Besides this, common salt is always present in considerable quantities, not only in animal excreta of all sorts, but also in kitchen refuse, etc., which forms a large part of ordinary sewage.

It is easy to determine, with great accuracy, the quantity of salt present in water or in other neutral solutions, by using a standard solution of silver nitrat, with a few drops of potassium chromat to act as an indicator. The red cromat of silver produced by the latter is decomposed into silver chlorid as long as any chlorides remain in solution. But directly the latter have been precipitated, the silver chromat gives a red or orange color to the solution. Thus as long as there are soluable chlorides present,

$$AgNO_3 + NaCl = AgCl + NaNO_3$$

but when they have all precipitated,

$$2AgNO_3 + K_2CrO_4 = Ag_2CrO_4 + 2KNO_3$$

The standard solution, of the strength used and described, contains 1 gram of silver nitrat in 401 cc. of water.

Experiment No. 142.

CHLORIDES (Quantitative Determination).

Measure 50 cc. of Croton water into a beaker, and add one drop of potassium chromat. Now run very carefully, from a burette, (See Fig. 128) the standard Silver Nitrat solution, stirring constantly with a rod. Notice how the red precipitat of silver chromat which is formed by each drop of the silver nitrat solution, dissolves when it is mixed in with the yellow liquid, and is converted into a white or yellowish cloud of silver chlorid.

When the red precipitat dissolves slowly and with difficulty, add the silver nitrat solution only a drop at a time, stirring well after each addition, until the color of the mixture just changes from yellow to orange or orange red. Then stop, read the burette, and the number of cc. of standard solution used (for this quantity, 50 cc. of water) will equal the number of grains of sodium chlorid in one gallon of water. Repeat this test with well-water.

Fig. 128. Method and Apparatus of Quantitative Determination of Chlorides in Water. A Standard Silver Nitrat Solution Is Added to the Water.

WATER FOR MANUFACTURING PURPOSES.

Experiment No. 143

QUALITATIVE TESTS.

Half fill three test-tubes with well-water, and test them as follows:

1. *For Chlorides.*—Add one or two drops of dilute nitric acid and one or two drops of silver nitrat. Result—precipitat of silver chlorid.

2. *For Sulfates.*—Add one or two drops of dilute hydrochloric acid and one or two drops of barium chlorid. Result—precipitate of barium sulfate.

3. *For Lime.*—Add one or two drops of ammonium hydroxid and ammonium chlorid then add a little ammonium oxalat. Result—precipitat of calcium oxalat.

Repeat these tests with Croton water, and notice that in this the precipitates are almost imperceptible, altho quite distinct in the well-water.

Quantitative Determination of Hardness. Place in a stoppered bottle 100 cc. of Croton water and add, from a burette, some "Standard Soap Solution," shaking well after each addition. Stop when a permanent lather is formed, and when, on shaking, it sounds and feels *soft.*

Each cc. of soap solution used is equal to a quarter of a grain of calcium carbonat in one gallon of water.

Repeat this test with 50 cc. of the well-water. Notice the formation of a "false lather" of lime or magnesium soap before the true *soft* lather. With this quantity of water, each cc. of soap solution corresponds to half a grain of calcium carbonat per gallon.

MINERAL WATERS.

Experiment No. 144

Test the sample of mineral water as follows:

1. *Bicarbonates of Sodium, Calcium and Magnesium.*

(a) Notice that the water is alkaline to test papers, after it has been boiled for a minute or two to expel the carbon dioxid.

(*Continued on page* 341)

This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**

The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of **$3.00** is awarded; for the second best idea a **$2.00** prize, and for the third best prize of **$1.00.** The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

HOW I MADE A "RADIUMGRAF."

I am sending you a picture, or rather "radiumgraf," in the hope that it may prove of some interest to fellow experimenters.

The picture was made with a spinthariscope. It was made thru two thicknesses of black paper. The word "Radium"

An Interesting Radium Photo Which Can Be Made By Anyone Possessing a "Spinthariscope."

was cut out of heavy lead foil and pasted on the paper so as to read backwards. An ordinary photographic plate was placed, emulsion side up, under the paper. Then the lens of the spinthariscope was removed and the part containing the radium salt was placed over the first letter. It should be left on each letter for at least forty-eight hours to get good results.

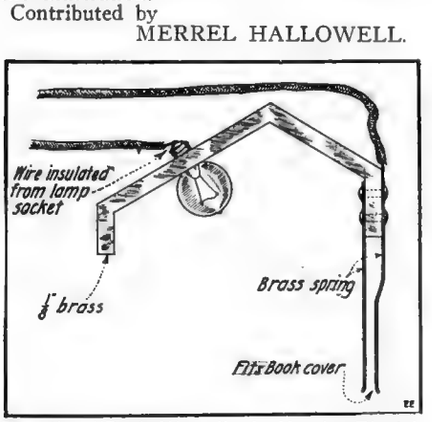
As will be seen the lead foil stops the rays, while the black paper does not. In this respect they are similar to X-rays.—

Contributed by
VERNON G. CLEMENTS.

A MINIATURE "BOOK" LIGHT.

Here is a miniature light for use on books when traveling, etc. A simple book light can be made by bending a strip of brass ⅛-inch thick and 1 inch wide, as shown in diagram. Bore a hole thru it large enough to receive the lamp, which should fit snugly. Attach two strips of thin spring brass ½-inch wide to the other end of the first piece of brass to act as spring, which can be slipt over the cover of the book. The wire connections are shown in the illustration.

Contributed by
MERREL HALLOWELL.



For the "Book-Worm"—A Handy Electric Book Light That Clamps on Cover. A Flashlight Battery and Lamp Complete It.

SECOND PRIZE, $2.00

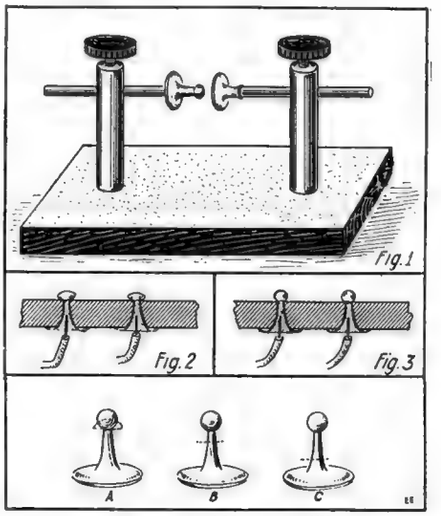
THE COLLAR BUTTON AN ELECTRIC NOTION.

Fig. 1 shows a spark gap made of a base and two binding posts of the type shown. Simply pass the wires from the secondary of a spark coil thru the posts. Next slip on the buttons, as illustrated, and adjust the distance.

In Figs. 2 and 3 the buttons are used as contact points (as for example, on a loose coupler). In Fig. 2 the board must be of a thickness equal to the length of the button less its head. Drill a hole large enough to pass the head of a button, which head is then flattened. Now place the wire in the hollow bottom of the button and solder it

In Fig. 3 the board may be of a smaller thickness, as here the button is shortened by cutting off the bottom part (Fig. C). Drill a hole large enough to pass the neck of the button, but not the head. Flatten the head (if wanted) and the bottom. Then insert the wire and solder.

Contributed by B. DOPPKE.



Spark Gaps, Switch Points, ad lib.—All Are Possible to Mr. Doppke If He Only Has a Few Spare Collar Buttons on Hand. Look Under Pa's Chiffonier Where You Will Find Dozens of 'Em, Fellow "Muckers."

Ye gods, what next? After this we presume one of our ardent contributors will send in a design of a 10 H.P. dynamo made of 27 assorted buttonholes, a thimble and a package of hairpins.

And, alas, the worst of it is that Mr. Doppke's suggestions are not half bad.—Editor.

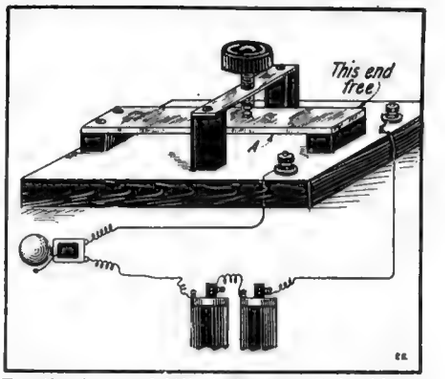
GLASS-BLOWING LESSONS.

In the October number there will appear the second paper of a series by Prof. Herbert Metcalf on the art of glass-blowing. These lessons explain every step with clear illustrations, so that you can learn the subject easily.

THIRD PRIZE, $1.00

FOR PLUVIUS' SAKE—RAIN ALARMS AGAIN.

I give herewith a diagram of a rain alarm which I think original. Its principle lies in the fact that, when a board is wet



For the Love of Mike! Another Rain Alarm. A Thin Wood Strip Bends When Wet and Closes an Electric Bell Circuit.

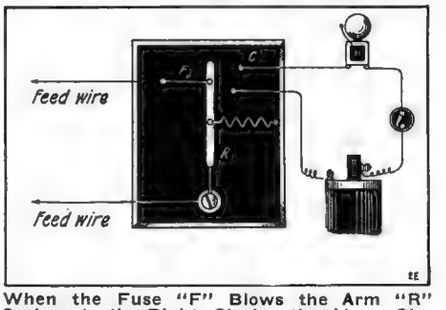
on one side, it warps. Referring to diagram, rain falls on board A, causing it to warp, closing contacts and ringing bell in circuit. Board A has one end free to permit its warping. The thumbscrew is turned until correct distance is obtained.

Contributed by JACOB E. VOLLMER.

A "BLOWN" FUSE ALARM.

Sometime ago while doing some experimenting which involved the blowing of fuses, I could not readily tell without testing for current, whether my fuse was blown or not, so I hit upon this scheme.

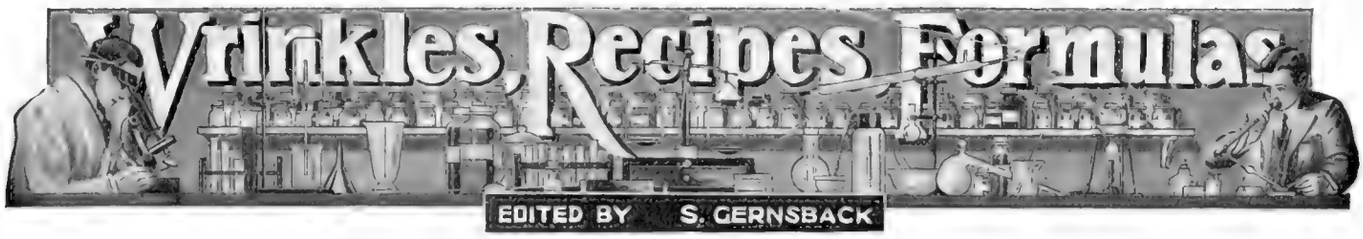
I first procured a base of wood of the size measuring two inches larger than the rod R, which can be of brass or copper and should have three small holes bored in it. The one at the top holds the fuse wire F. The other end of the fuse wire is twisted around the post connected to the feeder. The center hole has a spring fastened so that its tension draws the rod up against posts C, closing the bell circuit and ringing the same. The rod is pivoted at the bottom hole. The feeder should be connected to



When the Fuse "F" Blows the Arm "R" Springs to the Right, Closing the Alarm Circuit.

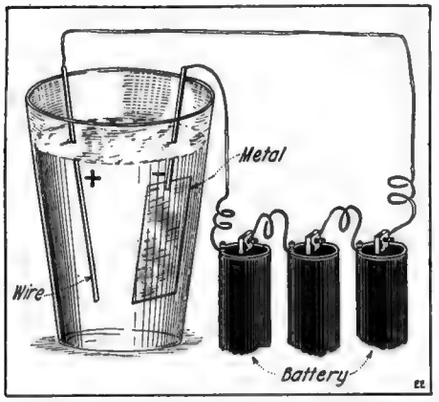
the fuse wire so that when blown the rod will be disconnected from the feeder.

Contributed by BERNARD COHAN.



ELECTRO ZINC PLATING.

To zinc plate steel and other metallic objects mix together about 4 drams of zinc sulfate with 4 ounces of water. Place



It's Easy Enough to Zinc Plate an Article, as You Will Find In Following the Instructions Herewith.

this solution in an ordinary glass jar; next fasten a wire to the positive pole of a battery. Let this wire lay submerged in the solution. The wire which you have fastened to the negative pole of the battery should be arranged so that it will hold some metal object which is to be zinc plated. Drop the wire with object to be plated in the solution. Care must be taken not to let the two wires touch, for this will cause a short circuit of the battery. Using a 4-volt 60-ampere hour storage battery the action of the solution will be much quicker and the quicker will the zinc deposit itself on the object connected to the cathode.

Contributed by ED. H. RANSON.

THE MYSTERIOUS FIGURE NINE.

Has it ever occurred to you what strange feats may be performed with figures? Take the figure 9, for instance. Multiply it by 2, and you get 18; and 1 and 8 make 9. Five 9s are 45 and 4 and 5 make nine again. Three 9s are 27, and 2 and 7 make 9. Four 9s are 36, and 3 and 6 make 9.

Take any row of figures you fancy, say 8642, and if you reverse them and subtract 8642—2468—you have left 6174, which added together makes 18, or twice 9. Take the 18 and 1 and 8 make 9 again. If you take five figures, say 76543, reverse them, 34567, and subtract you get 41976, which, added together, makes 27—that is, 2 and 7 make 9, or three 9s are 27.

Thirty-seven is another number specially adapted for figure juggling. Multiply by three, 37 becomes 111; and no matter what multiple of three you use the figures in the results will all be alike. Twelve times 37 is 444, 37x21 becomes 777, and so on.

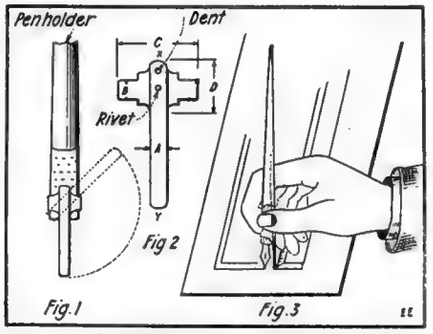
HOW TO DRAW LINES WITH WRITING PEN.

Those who have tried to draw straight lines with a writing pen and rule, nine times out of ten have obtained an unsightly blot for their labors.

Neat and clean-cut lines may be drawn with the use of the following device. The thickness of the lines will depend on the kind of pen points used. The guide arm (A) may be constructed of brass, altho steel is preferable in this case. The band (B D) should be made of spring steel, a piece of spring of an old clock would be sufficient. All that is required of the material would be that it should hold its form and not be easily bent.

A rivet is fixt to hold the guide arm and band together. Make a dent with a center punch above the rivet both in the arm and band to hold the former in place, as in the case of the extension or commonly called zigzag rule. No dimensions are given, altho for an ordinary pen-holder (A) could equal $\frac{3}{16}$", B=¼", C=1⅛", D=½", and XY=1¼".

A desirable feature of the device is that the guide arm may be folded so that the pen may be dipt in the ink bottle as shown in Fig. 1, and in that position it can be used



To Draw Straight Lines Is Not So Simple a Matter as You Think, but with a Little Help You Will Soon Attain Perfection.

as a clip to hold it in the pocket also. The band may be constructed in any design suitable to the maker.

Contributed by D. HUGHES.

WAX FOR BOTTLE SEALING.

Mix rosin or cheap sealing wax with an equal amount of beeswax in a water-bath. Dip bottles in hot solution and lay on side until dry.

MISCELLANEOUS RECIPES AND FORMULAS.

TO SOLIDIFY ALCOHOL—Heat 500 parts of denatured alcohol over a water bath to about 140 deg. F. and add 1 part of gumlac and 15 parts of dry Venetian soap (powdered).

BLUING (COLORING STEEL)—Small articles made of steel are very often blued. A very convenient method for the experimenter is to place the articles in an iron pan containing a quantity of clean dry sand over a fire. Move the pieces around constantly until the desired color is achieved, then remove and plunge into clean oil. It is very necessary that the metal to be colored is clean.

TO GIVE STEEL A BLUE-BLACK COLOR—At times a blue-black color is preferable to a blue. Melt together in an iron dish 10 parts of saltpeter and 1 part black oxid of manganese, and heat until a pine shaving thrown on the surface will catch fire. DO NOT ALLOW IT TO BOIL. Wire each piece of work and suspend in the mixture. Be sure that each article is completely covered. Do not let them touch the container at any point. When the desired color is obtained, wash in hot water, dry in clean sawdust and oil.

TO COLOR BRASS A STEEL-BLUE—Dissolve 3 drams antimony sulfid and 4 oz. calcined soda in 1½ pints of water. To this add 5½ drams kermes. Filter and mix this solution with 5½ drams tartar, 11 drams sodium hyposulfite and 1½ pints of water. Polished sheet brass placed in the warm mixture will assume a steel-blue color.

TO GIVE APPEARANCE OF CASE-HARDENING.—To 20 parts water add 1 part nitric acid. Immerse the piece in the solution for about 30 seconds, remove and wash in clean warm water and oil.

TO REMOVE PAINT—To remove paint without leaving any traces use ether on a piece of cheesecloth.

NO-GLARE HEADLIGHTS—Paste a piece of ordinary paraffin paper on the inside of the glass. A light so fixt is lawful and gives a good driving light.

LITMUS PAPER—This paper is prepared by boiling litmus, and steeping the paper in the liquid; this paper turns red when touched by acids.

ROSEWOOD COLOR—Boil in ½ gallon of water, 1 pound logwood chips and ½ pound red sandalwood. Apply to the wood, then go over it with a mixture of asphaltum and turpentine.

ACID PROOF TABLE TOPS—The following solutions render a table top impervious to the action of acids and alkalies.

Solution No. 1:

Iron Sulfate	2 parts
Copper Sulfate	2 "
Pot. Permanganate	4 "
Water	50 "

Solution No. 2:

Aniline	6 parts
Hydrochloric acid	9 "
Water	50 "

Two coats of solution No. 1 are applied with a brush—the second coat being applied after the first has dried. The surplus of the second coat is removed by rubbing, after which solution No. 2 is applied in two coats. When thoroly dry, a coat of raw linseed oil is to be rubbed well into the wood with a cloth impregnated with it.

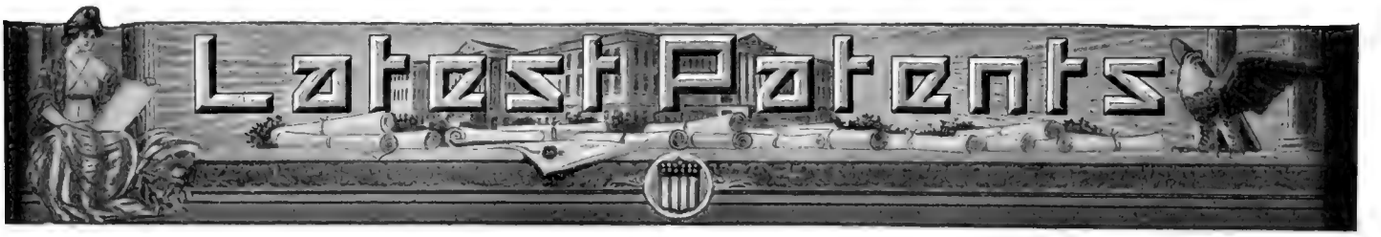
WALNUT STAIN—Dissolve in 30 oz. of water 1 oz. permanganate of potash. Apply this solution twice. Wait a few minutes and wash with clean water. When dry oil and polish.

TO STAIN PINE A WALNUT COLOR—Mix thoroly 1 pound burnt sienna, 1 pound dry burnt umber, and 4 oz. lamp black; add to 1 gallon of very thin shellac. Apply with brush. When thoroly dry rub down with fine sandpaper and then give one coat of shellac or varnish.

WALNUT STAIN FOR HARD WOOD—To 1 gallon of strong vinegar add 1 pound dry burnt umber, ½ oz. rose pink, and ½ pound dry burnt Vandyke brown. Mix thoroly and apply with a brush.

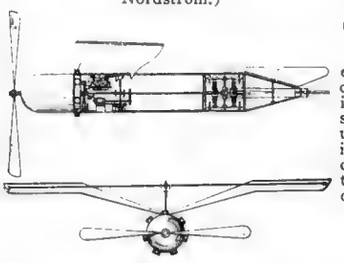
The above recipes and formulas have all been tried by me and have proven satisfactory in all respects.

Contributed by H. W. H. (Chemist.)



Automatic Aircraft Steering Mechanism

(No. 1,264,966, issued to Gustave Nordstrom.)

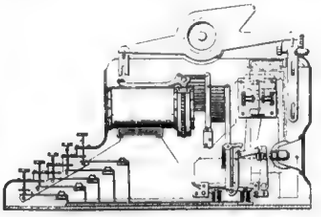


Among other things, the inventor claims to have solved the following: by gyroscopic and other electrical means, the stability of the aircraft is maintained in all directions, and also the vessel can be held, by means specified, upon a predetermined direct course if so desired. Again means are arranged whereby the wings of the craft will be banked automatically upon taking a curve, and the vessel may be set to follow various courses other than direct.

Electric Typewriter

(No. 1,268,491, issued to Paul C. Rawls.)

When any key is deprest for either a short or a long period of time, then the various operations necessary to complete the printing of a character and to return the type bar to normal position will be automatically and progressively carried out. The movement of the type

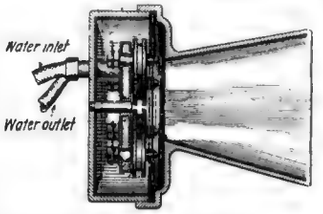


bars as the various keys are deprest is caused by electro-magnetic means, and to reduce sparking at the contacts whenever the electro-magnetic circuits are opened, the inventor provides a suitable condenser to absorb the extra energy created in the circuit by the self-induction of the magnet windings. A set of selective electro-magnets and an electro-magnetic power armature are utilized in operating this electric typewriter.

Multi-Unit Telephone Transmitter

(No. 1,264,507, issued to William Wallace Hanscom.)

A novel scheme for mounting the carbon cells is employed, and also in conjunction therewith a common cooling chamber is devised so that a continuous stream of cold water or other liquid can pass into the microphone chamber and circulate by the thin walls of the carbon

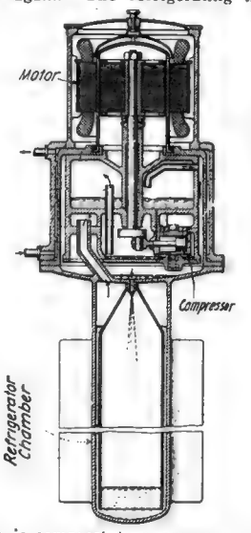


cells, and thus carry off the heat produced in these cells when the microphone is carrying a heavy current. In the design shown, six carbon chambers are used.

Electric-Driven Refrigerator

(No. 1,263,633, issued to Heinrich Zoelly.)

This refrigerator embodies an electric motor at the top as indicated, and there is also incorporated in the make-up of the machine a special form of compressor which is used in compressing the refrigerating medium, which may be methyl chlorid, and which in the course of the refrigerating process is used over again. The refrigerating me-

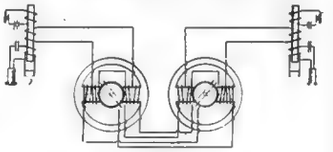


dium is comprest to a pressure corresponding to the cooling water temperature and passes hereupon into a lower pressure chamber, and it eventually finds its way thru a water jacketed chamber, and thence into a condensing chamber.

Current Amplifier

(No. 1,264,813, issued to August J. Kloneck.)

An amplifying telephone relay is interposed between the signal stations, embracing two dynamo-electric current generators designed with suitable differential regulating coils as the diagram shows. Also the inventor provides rotary members in

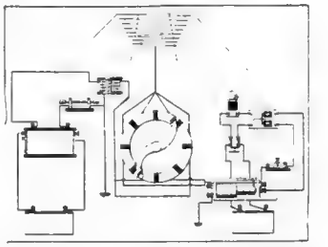


these relays which do not have any collecting rings or commutators. The amplifying coils of the relay generators are arranged so as to be cut by lines of residual magnetic force of a rotating armature bobbin, which is induced in the latter thru the field coils of a generator. A current from a transmitter surges in the same direction thru the differential coil as thru the main field coil and thus energizes the generator; but an amplified current from this generator surges thru a differential coil in the opposite direction to that in the main coil, thus nullifying its action.

Automatic Wireless Signal

(No. 1,265,633, issued to Gustaf Engelbrekt.)

An automatic wireless transmitting and receiving scheme for installation on ships, etc., the principal object of which is a motor-

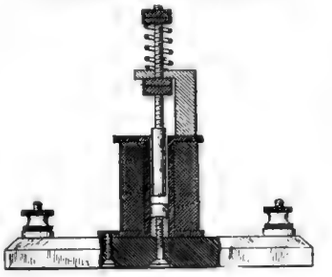


operated switch which alternately cuts in the radio transmitting and receiving set on the antenna. The speed of the switch can be regulated so that radio signals can be sent out and received in alternation during brief or sufficiently prolonged periods to be effective. The switch may be operated by electric motor.

A. C. Telegraph Sounder

(No. 1,265,589, issued to Arthur W. Beauprie.)

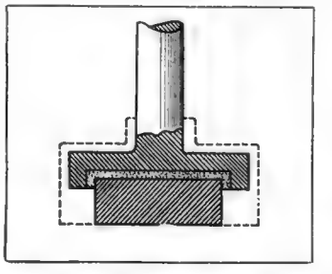
He provides a duplex core so arranged that there will be a mutual attraction between the two parts thereof, irrespective of the character of the current passing thru the solenoid or magnet. In this way, the inventor claims, the results are such that the residual magnetism in the two core members will at all times be great enough to hold the same in ocntact during the passage from a positive to a negative wave.



Electrical Contact Point

(No. 1,264,685, issued to Giuseppe Alberto Rignon.)

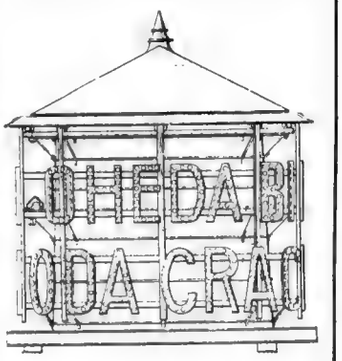
This contact point is formed of tungsten or molybdenum, having an exceedingly high melting point, and which is united with the support by electro-thermical welding at a very high temperature so as to render the whole contact member electrically homogeneous. In this way it will have a minimum electrical resistance, and this resistance is further reduced by means of a coating of some such conducting metal as copper or silver around the contact face of the support, with the exception of the two faces between which the break takes place.



Revolving Electric Sign for Water Tanks

(No. 1,268,375, issued to Frederick William Meyer.)

This novel patent covers specific means for mounting the revolving electric sign which is of the circular type and so arranged as to be suspended on tracks running around the tank. An electric motor works in a toothed rack mounted around the interior surface of the sign in such a way as to propel it continuously as long as the motor is operated. Electric current for operating the lights on the revolv-

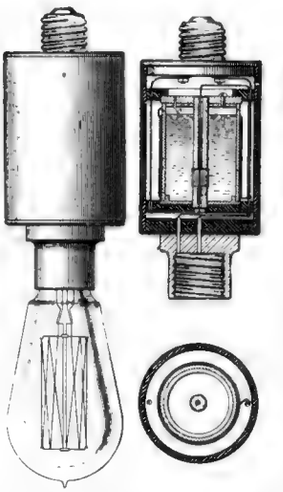


ing sign is carried to the lamps thru insulated rings and brushes.

A Lamp Socket Meter

(No. 1,264,982, issued to Edmund O. Schweitzer.)

This meter involves a small electrolytic cell which is appropriately connected into the lamp socket so that after a certain length of time the elements making up this cell will be decomposed by the pas-



sage of the current feeding the lamp, and which will cause the circuit of that lamp or apparatus to open. Before this lamp or apparatus can be again used, and more electric power consumed, the owner has to screw another meter unit in the socket, a supply of which he could have on hand of course. Novel means are provided whereby the consumer is notified by a flickering of the light a short time before the current is shut off by the electro-chemical decomposition of the meter elements, so that he will not be left in the dark.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay $3.00 prize each month for the best photo. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

In this issue we publish some interesting facts with excellent photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a snappy one like it each month. Here's our proposition: Why not write up your "Electrical Lab.," in not more than 500 words. Dress it up with several good, clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The prize awarded to such articles will range from $3.00 to $10.00. And "Bugs"—don't forget to make your article interesting. Typewritten articles preferred. Address the Editor of this Department.

THIS MONTH'S $3.00 PRIZE WINNER—EUGENE McGOWAN

HEREWITH are five photographs of my experimental laboratory. The lower right-hand photograph shows my chemical laboratory. The table upon which the apparatus stands was constructed from an old counter that was once used in a grocery store. In the center of the table there is a small basin that serves for washing test tubes, etc. There are also spigots for hot and cold water. Shelves were placed on the top to hold the chemical bottles as the picture shows. It may be of interest to the readers of the ELECTRICAL EXPERIMENTER to know that this table cost less than $4.00 to make, including the shelves, sink and the pipe fittings. There are about one hundred chemical reagents, including a few of the rarer elements like Radium Bromid 40X and Uranium Metal. I also have balance scales, Kipp's apparatus for generating sulfuretted hydrogen, condensers, burettes, and other common laboratory glass ware.

The center and upper left-hand views show the Electrical "Lab." and most of this apparatus was constructed from data given in articles that have appeared in the "E. E." In the right-hand corner of one photo may be seen the vacuum pump, which was constructed according to the directions given in the "E. E." by Raymond F. Yates, November, 1917, issue. There are also spark coils, Tesla coils, a Hughes induction balance, galvanometer, storage batteries, static machine, Leyden jars, a small dynamo, several motors, Geissler tubes, a synchronous motor made according to the one described in the "E. E." April, 1918. Storage batteries are kept in a box under the table. The top right-hand photo illustrates my Tesla coil in actual operation. It stands two feet high and throws a discharge about one foot long and several inches thick.

Eugene McGowan, Philadelphia, Pa.

Phoney Patents

Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offixx for the relief of all suffering daffy inventors in this country as well as for the entire universe.

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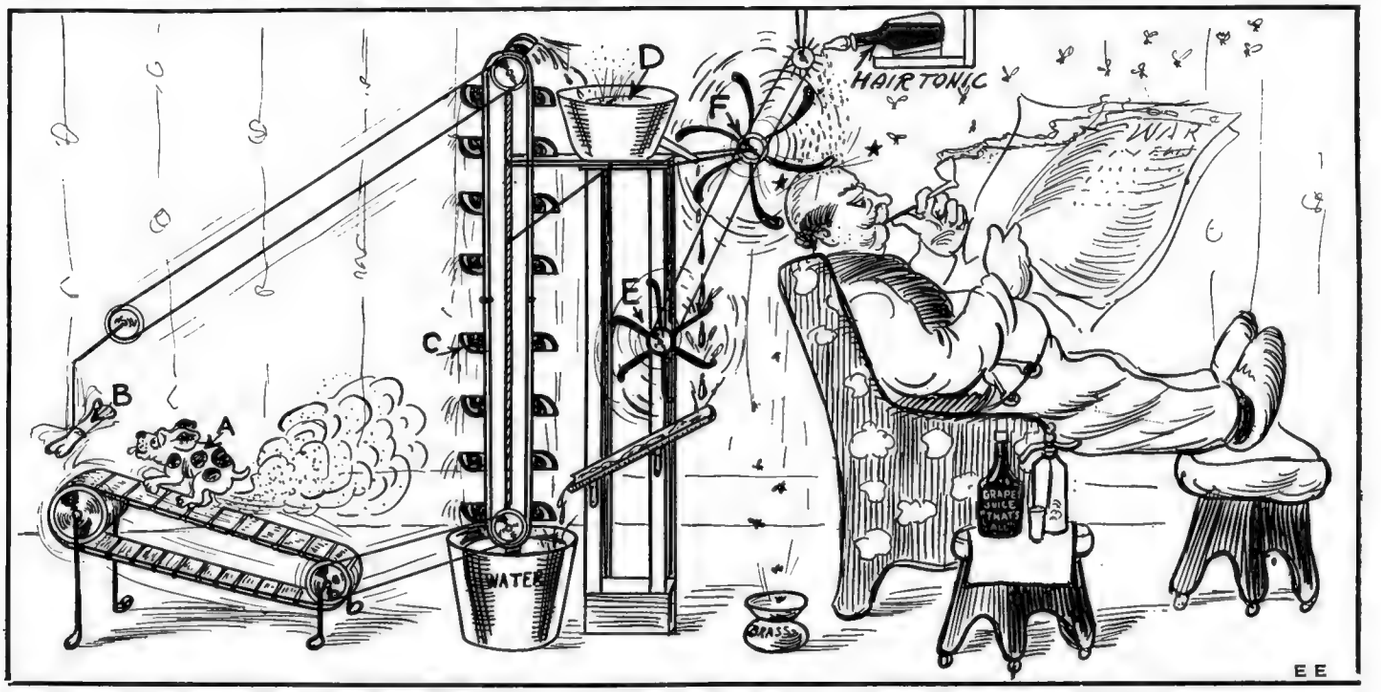
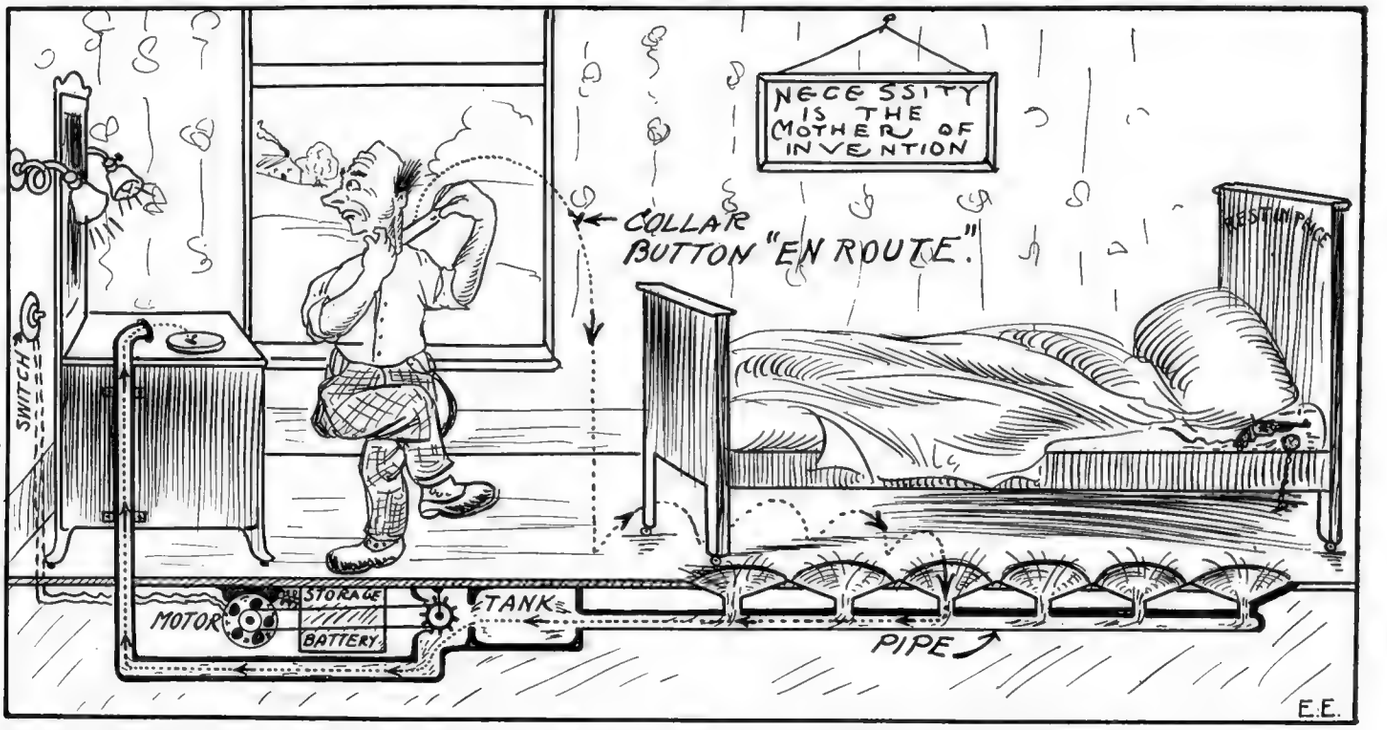


Prize Winner: BALDHEADFLYSWATTER. Be it known that I, Dickson Reck, have invented a startling and withal hair-raising invention for the purpose of refreshing baldpated old ladies' and ginks' who are troubled in the summertime with the usual nuisance—flies. My apparatus, which is simplicity itself, operates as follows: A small but powerful mutt "A" preferably of the genius "homo gazabo" is caused to run perpetually after the bone "B," on a tread power, said tread power being connected by means of a suitable belt to a series of cups mounted on an endless belt. This belt carries the cups around thru a tank of water, and the cups as they reach the maximum of their upward movement, discharge the water into a basin "D," which allows the water in it to ooze thru a nozzle onto a water turbine, "E." The water discharged from the turbine passes thru a shoot and back into the original water tank. The turbine "E" is belted to a flexible rubber fly-swatter "F," which when not busy killing flies and other insects, causing them to fall into the combination fly-container and cuspidor, is caused to massage the owner's baldpate with his choice brand of hair tonic. The belt from the top of the water bucket hoist, connects with the ham bone "B," to make it wabble thus irritate the mutt "A" more efficiently. Inventor, Dickson Reck, Gary, Indiana.



COLLARBUTTONFINDER. Behold! my latest and greatest invention! An automatic electric collar-button-finder or retriever which should be a boon indeed to all bachelors; not to mention the married gents, whose wives regale them periodically and regularly, especially on bright Sunday morns, with long-winded exhortations and admonitions to "get drest at once for church." Zip! goes that infernal collar button under the bed, of course. I provide herewith a guaranteed retriever for all unruly collar buttons, involving an automatic electric vacuum cleaner which is connected with a series of openings one foot apart all over the boudoir floor. Storage battery connects with the lightning rod on the house and is charged free. The storage battery runs the motor, and the motor runs the vacuum pump. Zip! goes his button—Wham! goes the electric switch, and Presto! comes the button from the trenches right into your jewelry tray.—Inventor, Franklin Kral, Washington, D. C.

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

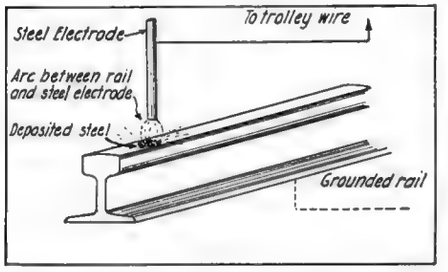
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

ARC WELDING OF RAILS.

(947) Lewis F. Bailey, Spartanburg, S. C. writes the Oracle:

Q. 1. He asks several questions relative to arc welding.

A. 1. Your information is at hand; such a welding scheme is quite possible, but you have forgotten to mention the voltage, etc.



Utilizing the Intense Heat of the Electric Arc Steel Rails and Plates are Now Welded by This Method.

However, the general method is to ground one terminal of the apparatus as shown in the accompanying diagram, and the other terminal is usually of steel or carbon, depending upon the particular case for which you desire to use it.

If you refer to the article on the *Electrical Furnace* in the April, 1918, issue of this journal, you will obtain some idea of the size of electrodes to be used.

We make note of a particular case wherein the electrical railway companies use an electrode of steel and the rail as the other electrode, and whereby the arc causes the metal to be welded to the rail, which is the other electrode.

COMPUTING CAPACITY OF CONDENSER.

(948) R. Howell, Los Angeles, Calif., asks:

Q. 1. About the size of secondary capacity for one-inch spark coil and how to compute the area of dielectric required.

A. 1. The value of the capacity for use across the one-inch spark coil secondary, should be adjustable to .02 m.f., and should consist of about 2,200 square inches of tinfoil placed between glass plates at least 1/5 of an inch thick. Below is given the formula for calculating the area of active dielectric:

$$\text{area} = \frac{t \times C \times 10^{10}}{K \times 2{,}248}$$

Where: t = thickness of dielectric in inches.
K = dielectric factor.
C = capacity in micro-farads.
Area in square inches.

ELECTROLYTIC GAS PRODUCERS.

(949) John L. Shaw, Hickman, Ky., asks several questions concerning the electrolytic gas producer.

A. 1. If an electric spark is past thru the medium wherein oxygen and hydrogen gases are mixt, combustion takes place almost instantaneously thruout the entire mass, which will cause a sudden increase in volume, or in other words an explosion will take place.

An extensive article covering a new invention which utilizes the electric current to decompose the water so that the hydrogen gas can be used for an explosive mixture in connection with engines for autos, etc., was given in the June, 1917, issue of the ELECTRICAL EXPERIMENTER.

The rate of production of these gases depends upon the area of the electrodes, the amount of current flowing, the resistance of the electrolyte, etc., and it must be borne in mind that by properly adjusting any of the above values, we can maintain a constant production of gases.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 to 150 words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York City.

RADIO TROUBLES.

(950) C. Vetter, Wessington Springs, S. D., writes the Oracle about several radio problems which are puzzling him. We advise him as follows:

A. 1. The Tigerman vacuum tube to our mind is as good as the rest of the tubes from our experience. This tube can be used with good results as an amplifier.

A. 2. The appended diagram shows the connection for two-step amplification. For one step amplification, leave out the third Audion circuit and place the telephone receivers where the transformer T_2 now is.

A. 3. We herewith give dimensions for several types of loose couplers. (3,000 meters.)

Primary 5" long x 4" dia. with No. 24 or 26 S. S. C.

Secondary 4½" long x 3½ dia. with No. 28 S. S. C.

The secondary should be wound with No. 34 (Audion circuits.)

6,000 Meters

Primary 8½" long x 5" W with No. 24 S. C. C.

Secondary 8" long x 4½" W with No. 30 S. C. C.

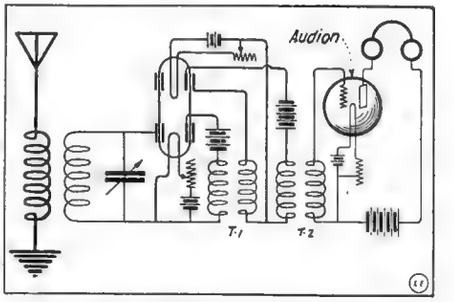
The secondary should be wound with No. 34 (Audion circuits.)

12,000 Meters

Primary 11" x 7½" with No. 24 S. C. C.

Secondary 10" x 7" with No. 30 S. C. C.

The secondary should be wound with No. 34 (Audion circuits.)



Two-Step Amplification with the Tigerman Vacuum Valve and an Audion Bulb.

We use finer wire on the secondary because by doing so and with a given number of turns, an increase in voltage is obtained, the induced E. M. F. being propor-

(*Continued on page* 336)

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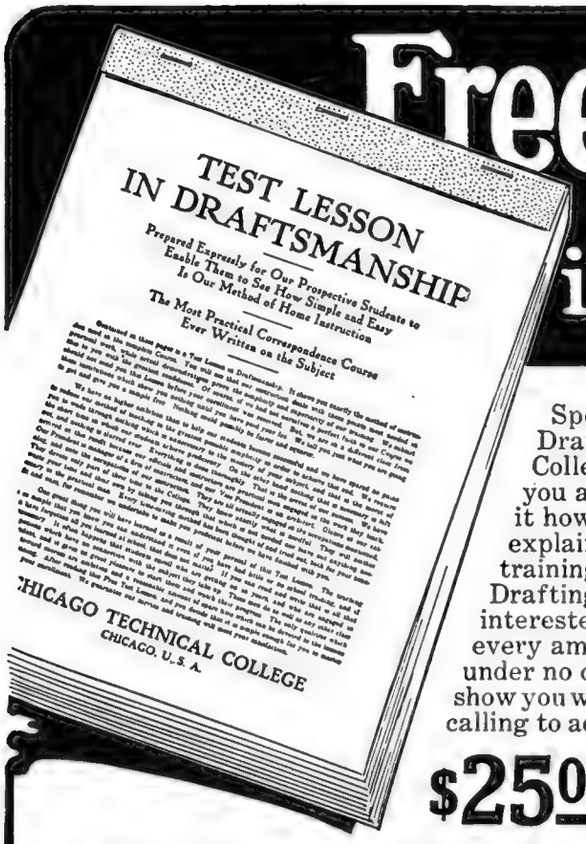
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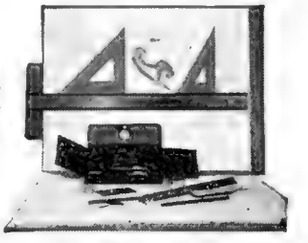

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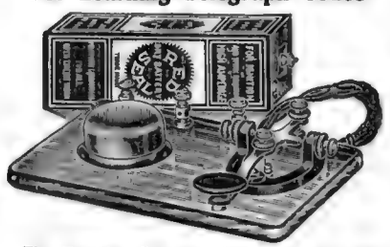
For Learning Telegraph Codes



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

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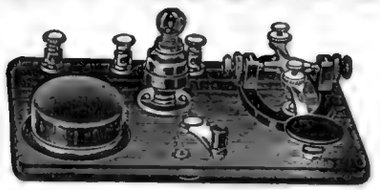

This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.

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THE ORACLE.

(*Continued from page* 334)

tional to the number of turns used on the primary and secondary. For example—When ten turns of the primary are being used, suppose we happen to get best results with 50 turns in the secondary. Now this means that the E. M. F. is being increased in the ratio from 1 to 5 times its value in the primary circuit.

MULTI-AUDI-PHONE HOOK-UP.

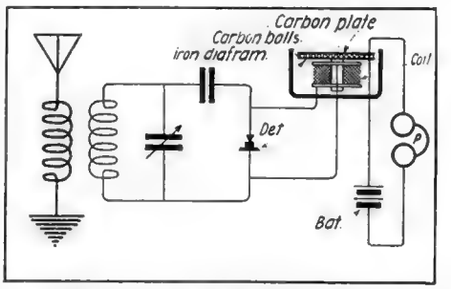
(951) D. Horace Parrell, Philadelphia, Pa., asks:

Q. 1. For a design of regenerative Audion receiving set.

A. 1. A design for a short-wave regenerative Audion set is fully described in the December, 1916, issue of this journal. A tickler coil is nothing more than an inductive coupler with sufficient inductance necessary to transfer the oscillations from the grid to the plate circuit of the Audion. It should consist of a primary tube wound with No. 24, and a secondary wound with No. 28 magnet wire; the dimensions are 6 inches long, 4 inches wide. It is advisable to take about ½ dozen taps from each coil.

Q. 2. How is the Multi-Audi-Phone hooked up?

A. 2. The underlying principle embodied in the construction of the Multi-Audi-Phone is shown in the diagram. It consists of a high resistance 'phone magnet actuating an iron diafram which has some fine carbon balls on its top and is then



The Hook-up of the Multi-Audi-Phone Amplifier in a Radio Receiving Circuit.

covered with a carbon plate which is connected as shown, the signals being increased by virtue of the fact that the resistance between the balls is altered when a radio signal is received. By properly connecting an apparatus of this kind, messages can be automatically recorded. In fact, one of the leading companies are at present selling such a machine for recording purposes.

LAMINATED IRON V. S. EDDY CURRENTS IN A. C. MOTORS.

(952) Ivan Redeker, Minidoka, Idaho, states that he has had considerable trouble in operating an A. C. motor which he has built.

A. 1. After carefully considering the various details as outlined by you, we offer the following suggestions. The laminations which went to make up the field and armature should have been shellacked, for as is the case in all A. C. machines, Eddy currents are generated, and are one of the biggest factors to handle. These Eddy currents tend to stop the motion of the armature. This effect can be seen very easily if we rotate a copper disc between the poles of a powerful electro-magnet. It will be noticed that when the current is off, the copper disc can be rotated very freely, but as soon as the current is switched on pro-

(*Continued on page* 338)

TELEPHONE APPARATUS; AN INTRODUCTION TO THE DEVELOPMENT AND THEORY. By G. D. Shepardson, Sc.D. Size 6¼ x 9½ inches, Cloth Bound, 115 illustrations, 337 pages. Publishers, D. Appleton and Co., New York and London, 1917. Price, $3.00.

A most complete and authentic work on modern telephone apparatus, covering all the important points in daily practise from the lineman to the planning and research engineer. The principles are fully discust so that even the layman may glean a good deal of valuable information, while to the more advanced worker, especially those having a knowledge of algebra, trigonometry and the laws of physics and currents, the book will prove a great benefit.

Many circuits as used in American telephony practice are included in the work with a complete description and working detail of each part.

A subject admirably treated, so that all may understand and yet gain specific knowledge thereof—a work which should be possest by everyone interested in telephony, especially students of the art.

THE CALCULATION AND MEASUREMENT OF INDUCTANCE AND CAPACITY. By W. H. Nottage, B.Sc., 145 Pages, 5½ x 8¾ inches. Cloth Bound, Price, 60 cents. The Wireless Press, Ltd., London, England.

This book is a very helpful aid to those who have occasion to design, calculate or measure the values of inductance or capacity, as encountered in radio work, telephone work, etc. The treatise consists of numerous examples worked out, such as the inductance of a straight wire carrying either a.c. or d.c., the inductance of different types of coils, the capacitance of different forms of condensers, and antennae, etc. There are also described a number of methods for the direct measurement of inductance and capacity, e.g., by the Fleming-Anderson bridge, Butterworths' bridge, Owens' bridge, Hays' bridge, Wiens' series bridge, Fleming and Dyke bridge, etc., etc. Towards the end of the book there is given a set of tables which aid considerably in the quick solution of problems, a few of the tables of which are: Nagaoka's factors for the Inductance of a single layer coil; Capacity of parallel wire antennae; Wave-length of an aerial with series inductance; Wave-length of antennae with series capacity, et cetera.

As a whole the book fills an important breach in radio literature and will prove of use to all engaged in radio and other branches of electrical science.

LEARNING TO FLY IN THE U. S. ARMY, by E. M. Fales. First Edition, 180 pages; fully illustrated; size 7¼ x 5 inches; flexible covers; cloth bound. McGraw-Hill Book Co., New York, publishers, 1917. Price, $1.50.

A complete pocket manual of aviation, giving all the points of the game from A to Z. It has evidently been compiled with extreme care and attention to details and should find a ready welcome from all interested in flying, either for army practise or sport.

Early efforts in the air are described with a full history of the first attempts of flying and the various causes which led to failure, until the Wright brothers made their first successful flights.

From the failures and successes of various experiments the present army aeroplane has been developed, and this is made the subject of very interesting reading.

Then follow numerous chapters giving the principles of flight, constructional details, motors, propellers, wings, controls, etc.

Of special note is the chapter on Cross-country Flying, which gives the pilot numerous hints on the care of his aeroplane during such a flight, the picking out of suitable landing places and all data which is necessary in making a successful flight.

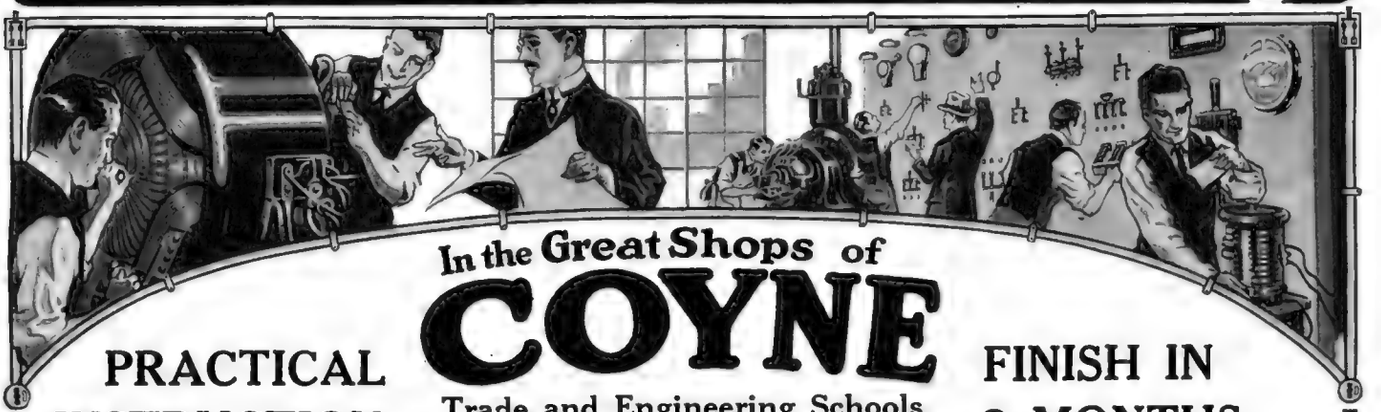
The erection of aeroplanes which have been shipt from the factory forms the topic of another interesting chapter, giving the correct methods to follow in setting up an aeroplane, with pointers on what and what not to do. This should prove of especial value to all, as much of the success depends on the proper aligning of the planes.

The proper inspection routine is carefully explained, and if rigidly followed will do much to prevent needless wrecks and accidents.

All in all, it is a work well worth reading by anyone, and right now it should be of inestimable value.

(*Continued on page* 338)

Learn Electricity



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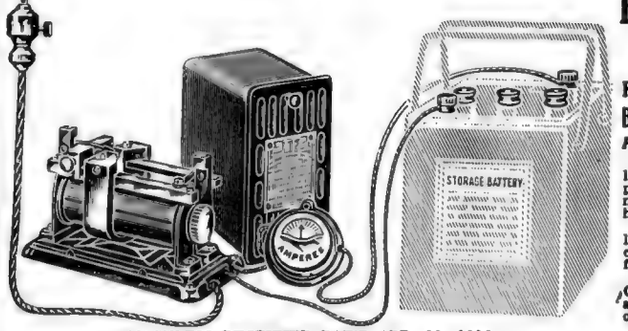

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Every blade individually tempered. This costs extra money and takes extra time, but gives a blade that cuts practically anything without breaking, or the teeth stripping.

The teeth are **milled** from the blank, not punched. This is also a slower and costlier process—but ensures sharp, square teeth that cut metal as easily as a rip-saw cuts wood.

We guarantee "RED DEVIL" Blades to last at least 30% longer than others.

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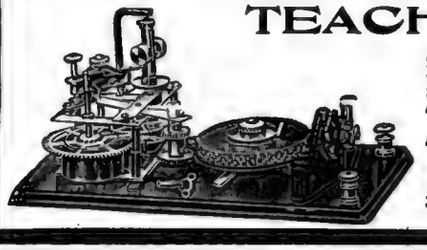

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THE ORACLE.

(*Continued from page* 336)

ducing the magnetic field, the motion of the copper disc is retarded at once; in fact, the effect is sometimes so great as to stop it entirely.

You will therefore see that since your motor runs, it must be due to this effect, and we advise you to shellac each plate of the armature and the field, and we are sure that when this is done the motor will run all right at the desired speed.

The running effect of the motor is not hampered much in your particular case in reference to the construction of the field poles. You state that the armature was turned down, the slots were cut in, etc. This is very bad for as you see the idea in the shellacking of the laminations is to insulate the stampings from one another, and therefore it is necessary to file off the slight remaining sharp edges which result from such operations.

BOOK REVIEW.

(*Continued from page* 336)

HOW TO FLY, by A. Frederick Collins. Cloth bound; fully illustrated; 182 pages; size, 5 x 7½ inches. D. Appleton & Co., New York, publishers, 1917. Price, $1.10.

A timely and useful book which should find a ready demand from all interested in aero matters, especially those belonging to or intending to join the Aviation Section of the Army or Navy.

Much attention is given to details and the author has certainly covered his subject well. With a brief history of flying the reader progresses, step by step, thru the important phases of the art.

The reason why an aeroplane flies is clearly set forth, as well as the mechanical conditions, the various conditions of the air, gravity, stability, pressures, etc.

A comprehensive chapter is devoted to the building of aeroplanes, covering practically everything from the general design, wings, etc., to rudders and running gear.

The engine is discust from every point of view, giving its theory, construction and application, with data on such refinements as self-starters.

The closing chapter deals with the qualifications necessary to become a successful pilot, where to learn to fly, etc. The aeroplane's uses in the present war and interesting notes and data giving rules and regulations for obtaining a Pilot's Certificate are included.

A large appendix contains the following information: The Barometer, Table of Altitudes, The Sperry Synchronized Drift Set, How to Make Aeroplane Calculations, and a chart showing the Organization of the Air Service of the U. S. Army.

MANUAL OF PHYSICAL TRAINING AND THE ORGANIZATION OF BAYONET FIGHTING. Size 6¼ x 4⅝ inches, profusely illustrated, dark blue cloth, stiff covers. This book was originally prepared by a Board of Officers of the United States Army. It contains 208 pages. Price 75c, publisht by National Military Publishing Co., New York.

It is a treatise on the subject of physical training, and gives in a very complete way the subject of marching, attention, and especially on setting-up exercises. It treats at the beginning on the rudiments of military requirements which are very essential. The different physical exercises are illustrated in various motions.

The chapter on rifle exercises is well presented. The illustrations therein show how the soldier of arms performs the various exercises with the aid of the rifle. The subject of gymnastic exercises is treated at length. It includes wrestling, boxing, gymnastic contests, one-legged tug of war, and the "siege." The subject of swimming is explained in a very clear manner, and the illustrations show the various motions and strokes. The authors give an excellent description of bayonet fighting.

OUR ARMY AND NAVY AND HOW TO KNOW IT. Edited by A. A. Hopkins, publisht by Munn & Co., New York., 4 x 5½ inches, profusely illustrated, 144 pages, lithographed stiff paper covers. Price, 50 cents.

The book is divided into two parts. In the first half of the book the author discusses the Army, and gives in the opening chapters the names of the

various organizations and the salaries of the men in the U. S. Army. Many illustrations are given of various insignias of the different branches of the U. S. Army to familiarize the civilian, or the man in the service with the different branches. A complete table is given of the forts, arsenals and cantonments of the U. S. Army, also special army schools, officers' training camps, National Guard tent camps, and a detailed Army map of the United States. A colored chart of Army insignia hat bands is also given, designating the character of service. An excellent double-page illustration showing the leading types of American aeroplanes is given. Several pages are devoted to the different types of war medals.

The publishers of the book print it in a reverse manner, so that half the book is consigned to the Army and other half to the Navy. In the second half the subject of our Navy is taken up, and the same order is followed in this portion as the first. Various colored plates are given, showing the rank of the Navy officers. An excellent color plate on shoulder marks for line officers, and insignia of rank of naval officers which are worn on the sleeves is also shown, including the various hat band insignias as worn by enlisted men. There can be very little chance for a civilian to be mistaken in determining the rank of the officers both in the Army and Navy, if he becomes familiar with the various insignias as given in this book.

EXPERIMENTAL MECHANICS.

(*Continued from page 327*)

predetermined diameter is reached. In order to guide one's self to cut to the proper diameter of the work, it will be necessary to use a measuring tool set to this diameter. The name of this tool is the *caliper*. There are two types, one called an *inside caliper* used in measuring the inside diameters, and second an *outside caliper* for determining outside diameters. The latter is the one which we are interested in since we desire to cut an outside diameter to a certain value. It will thus be advisable at first to set the legs of the calipers to the value of the predetermined value. Fig. 8 shows how a pair of calipers are set on a scale and adjusted until the second leg touches the value which is required in the turned down rod. The cutting tool is caused to travel back and forth and take a cut at each journey, which is continued until the work is reduced in size so that it will allow the calipers to *just pass over*. At this point the diameter of this portion of the work is the correct diameter of the predetermined size. Don't jam the calipers over the work; *feel* the size carefully. This is one of the tricks of the trade.

On very accurate jobs, the cutting tool is prevented from taking off any metal at a point where the diameter of the work is a trifle *larger* than the opening of the calipers. The remaining metal is removed by either a flat fine file or else with emery paper or cloth. This is done because the knife is unable to take a very fine cut, so it is practicable to use a file to bring the work to the proper finished diameter. Never use the calipers to gage the diameter of the work when it is revolving, as it will spoil the calipers or it may catch on the work, and may cause damage or an accident. Fig. 11, shows a piece of metal turned down to a certain diameter and the manner of applying the calipers in measuring it.

This is the first job that the amateur should thoroly master, and he will be surprised to see how much patience and time is necessary to be given in producing a *perfect* piece of work. This is a fundamental job and it should not be overlooked, as a number of the most important basic operations are inherent in this first job. Each and everyone of the progressive students of "Experimental Mechanics" should try his hand on this work and in the Seventh Lesson further interesting details as to "Metal Turning" will be given.

(*The next installment will appear in an early issue*)

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Thousands of men now know the joy of happy, prosperous homes because they let the International Correspondence Schools prepare them in spare hours for bigger work and better pay. You will find them in offices, shops, stores, mills, mines, factories, on railroads, in the army and navy—everywhere.

Why don't you study some one thing and get ready for a real job, at a salary that will give *your* wife and children the things you would like them to have. You can *do* it! Pick the position you want in the work you like best and the I. C. S. will prepare you for it right in your own home, in your spare time—you need not lose a day or a dollar from your present occupation.

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The first student was enrolled in the International Correspondence Schools on October 16, 1891.

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It is over five times the total enrolment of all the colleges, universities, and technical schools in the United States combined.

I. C. S. text-books are used in class-room work and for reference purposes by 304 universities, colleges, government schools, institutes of technology and vocational schools, by the U. S. Navy Department in its Shipboard Training Schools and by many of the largest industrial corporations.

About 500 students each month report advancement or salary increases as a result of the I. C. S. training. Reports of 1,000 typical students show that at time of enrolment their average monthly wage was $53.90. At the time they most recently reported advancement their average wage was $182.48 per month, an increase in earning power of $128.58 per month through I. C. S. training.

Reports on 27,000 typical students show 14,999 now receiving $1,500 a year or more; 2,451 receiving $2,500 or more; 413 receiving $5,000 or more; 20 receiving $10,000 or more; and 8 with annual incomes of $25,000 or more.

Note the number of I. C. S. Students in *your* State

State	Number	State	Number
Alabama	13,920	Montana	14,700
Alaska	1,560	Nebraska	18,240
Arizona	9,440	Nevada	4,800
Arkansas	8,600	New Hampshire	12,760
California	80,840	New Jersey	63,560
Colorado	35,060	New Mexico	6,760
Connecticut	34,140	New York	217,040
Delaware	4,600	North Carolina	134,700
Dist. of Columbia	9,280	North Dakota	6,600
Florida	9,780	Ohio	116,200
Georgia	9,480	Oklahoma	8,320
Idaho	10,720	Oregon	15,600
Illinois	296,840	Pennsylvania	170,720
Indiana	55,520	Rhode Island	13,380
Iowa	40,100	South Carolina	8,720
Kansas	36,000	South Dakota	6,760
Kentucky	9,780	Tennessee	15,020
Louisiana	11,680	Texas	39,520
Maine	22,460	Utah	16,420
Maryland	21,680	Vermont	7,680
Massachusetts	83,040	Virginia	21,500
Michigan	69,940	Washington	37,160
Minnesota	32,480	West Virginia	20,960
Mississippi	6,400	Wisconsin	42,320
Missouri	53,020	Wyoming	6,080

Navy, 15,000.....Total, 2,007,080

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Electrical Draftsman	RAILROADER
Electric Machine Designer	ILLUSTRATOR
Telegraph Expert	DESIGNER
Practical Telephony	BOOKKEEPER
MECHANICAL ENGINEER	Stenographer and Typist
Mechanical Draftsman	Cert. Pub. Accountant
Ship Draftsman	Traffic Management
Machine Shop Practice	Commercial Law
Gas Engineer	GOOD ENGLISH
CIVIL ENGINEER	Common School Subjects
Surveying and Mapping	CIVIL SERVICE
MINE FOREM'N OR ENG'R	Railway Mail Clerk
STATIONARY ENGINEER	Textile Overseer or Supt.
ARCHITECT	AGRICULTURE
Architectural Draftsman	Navigator
PLUMBING AND HEATING	Poultry Raising
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Formerly with Auditorium and Chicago Athletic Club, Chicago, the Denison Hotel and Columbia Club, Indianapolis.

The Manipulation of Glass Tubing in the Experimental Laboratory

(*Continued from page* 324)

around the short end before trying to break it, to prevent the glass from flying and cutting you in case you have a bad break. Immediately after breaking, smooth off all sharp edges of the broken ends with short quick strokes of the file. This is much quicker than rounding off the ends in the flame and serves the same purpose. Never leave glass tubing around the laboratory with sharp edges—file them all as soon as they are broken, and save yourself and your friends from being cut.

Tubing larger than one-half inch in diameter is somewhat harder to cut successfully. If one has a special cutter which will cut a groove around the inside of the tube it may easily be done. The best way, if no cutter is available, is to cut a deep groove half way around the outside of the tube and then try and break it as with the smaller sizes. It may or may not be successful, depending on the quality of the glass.

Trying to cut very large glass tubing without a special cutter is very unsatisfactory, yet may sometimes be accomplisht with a file and a hot iron. File a deep notch at the proper length on the tube and then touch the red hot point of a spike directly over it. Repeat until there is a tiny crack started. Then by repeatedly touching the tube just ahead of the crack with the hot iron, the crack may be led around the tube. The tube is then broken and the edges smoothed off.

The old method of breaking tops off bottles may be used to obtain large tubes from tall olive jars. Wrap several layers of string around the jar and then soak the string in gasoline, alcohol or kerosene. Light the string and just before the flame goes out plunge the jar into water. It ought to crack in a fairly circular line. If it does not, try until it does. Keep the jar turning all the time so that the heat from the burning string may be *evenly distributed.* Tubes made from bottles of this kind cannot be worked in the flame as they are made from too brittle glass, but are very useful in making certain kinds of apparatus, as for instance battery jars, etc.

MAKING SIMPLE BENDS.

Bends in glass tubing are progressively harder as the tubing enlarges. The entire success of the bend depends on the handling of the glass in the flame. It is not enough to stick the tube in the flame and then bend it when it gets red hot. A bend made in this manner is not a good one, and will break under the slightest strain.

To obtain a sharp bend, the narrow edge of the fish-tail burner should be used, twirling the tube rapidly until there is an *even reddish white glow* around the tube at the place where the bend is to be made. The tube must then be taken out of the flame, and *immediately bent* to its proper shape. A bend of over 90 degrees cannot be made in this manner. Also the tubing must not be too hot or a poor bend will result. Remember in all operations with glass tubing that it should be *heated slowly,* otherwise it will crack.

After a bend has been made and before it has been cooled, it must be *annealed.* This is done by holding the tube in the yellow flame and keeping it there until it is *thoroly sooted up.* It may then be allowed to cool on the mat. Every bend of any description must be treated in this way in order that its brittleness may be removed. A bend which has not been annealed has no strength.

To make wider bends a greater length of tubing must be heated. For this we use the entire length of the fish-tail burner and proceed as we did with the sharp bend. The greater the length heated the greater the curve to the bend. A sharp bend is not possible with large tubing. As a rule, the larger the tubing the larger the curve will have to be. In bending large tubing care should be taken that the tube is very *evenly heated thruout its circumference,* otherwise the inner part of the tube will buckle when it is bent. A bend of the buckled sort will not be strong, and will usually break while cooling.

In making all bends these things must be kept in mind and carefully observed. *First, the tube must be evenly heated and heated up gradually. Second, it must not be heated too hot. Third, the bend must be annealed by cooling it down gradually in a yellow flame until it acquires a coating of soot. Fourth, the bent tube must be laid down on the mat to cool.*

Bends made in the above manner may take a little longer to make than the ordinary rough and ready bends, but the experimenter will be amply repaid by the stability of the bent tubes, for the bend will be fully as strong as any other part of the tube.

It can easily be seen that by varying the length of the heated portion of the tube, and by repeating bends any desired figure may be made. In small tubing bends may be made 360 degrees if necessary. In large tubing this is not practical and four right angle bends will do the work as well.

CLOSING THE ENDS OF GLASS TUBING.

To close the end of a glass tube properly the end should be slowly heated for a very short distance only. While the end is melting down the tube should be continually rotated so that the closure will be even. It is quite a common mistake of many experimenters to melt down the end until the glass meets—but the end is not fused. The glass must be firmly fused over the end or there will be leakage thru the minute hole in the supposedly closed tube. You will find that the closed end will be much thicker than the rest of the tube and will break easily. These faults may be remedied by first blowing in the open end just as the glass fuses, and then by careful annealing of the end by sooting. Ends are most easily closed with a blast lamp as it allows the end to close quickly enough to prevent the glass from thickening. To obtain a square end on a glass tube after it has fused, it may be prest on a red hot plate and then annealed and allowed to cool. The sealing of tubes containing liquids will be described later.

(*See Part II in next issue*)

POPULAR ASTRONOMY.

(*Continued from page* 311)

ent members. Paths of comets pass around the sun at all angles and some comets move in their orbits from west to east while others move in the opposite direction or retrograde. The behavior of the asteroids and comets is not at all in accord with the theory that was, until recently, universally advanced to explain the origin of the various members of the solar system.

Some astronomers have made attempts to modify the nebular hypothesis that has held sway for so many years in order to make it fit in with more recent discoveries but others feel that a new theory is now required to explain the origin of the solar system. Several theories have been advanced but no new theory has yet definitely replaced the famous nebular hypothesis of the noted French astronomer La Place.

(*Next installment will appear in October issue.*)

ALGERIA HAS IMMENSE WATER POWER SITES.

A French engineer has found 35 localities in Tunis where dams can be constructed that can be made to provide from 30 to 600-horsepower of continuous energy.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 328*)

(b) Add some acid to the water. Notice the effervescence of carbon dioxid gas.

(c) Boil some of the water in a beaker for 5 or 10 minutes. Notice the white deposit of calcium carbonat and magnesium carbonat, which dissolved with effervescence in acids.

2. *Chlorides, principally Sodium Chlorid.* Determine the amount of sodium chlorid in the water, as described above, using however, only 5cc. of water for the test, diluting it with a little Croton water (distilled water will give more accurate results). In this case the number of grains of salt per gallon is found by multiplying by 10 the number of cc. of solution used.

3. *Sulfates.*—Test for these with barium chlorid and hydrochloric acid. In most of the common mineral waters this test will be very faint.

4. *Iron.*—In siphon waters and in most of the table mineral waters this element will not be present. When testing Saratoga waters, however, or any others where even small traces of iron are present it is generally possible to notice the brownish flakes of $Fe_2(OH)_6$ floating in the water.

To prove its presence, add enough nitric acid to make the water slightly acid, warm for a minute or two, and test for (Ferric) Iron with NH_4CNS.

5. *Calcium and Magnesium.*—Add ammonium hydroxid, ammonium chlorid and ammonium oxalat to some of the water. Result—precipitat of calcium oxalat. Heat, filter carefully, and test the filtrat for magnesium with Na_2HPO_4.

HYDROGEN PEROXID.

Hydrogen Peroxid, H_2O_2 was first prepared by Thenard in 1818, who named it "oxygenated water." Its occurrence in nature is not abundant, but it is sometimes found as traces in the atmosphere, rain and snow.

Preparation:—

Almost any acid acting on barium dioxid (BaO_2) will yield hydrogen peroxid, thus:

$$BaO_2 + H_2SO_4 = BaSO_4 + H_2O$$

Other reactions being:

$$Na_2O_2 + 2HCl = 2NaCl + H_2O$$
$$BaO_2 + H_3PO_4 = BaHPO_4 + H_2O_2$$
$$BaO_2 + CO_2 + H_2O = BaCO_3 + H_2O_2$$

Hydrogen peroxid solution when used for medicinal purposes must be as free as possible from soluble salts, especially barium, and for this reason, only such acids as sulfuric and phosforic (usually both), which form insoluble barium compounds, are used.

For bleaching, oxidizing, and as a preservative agent, the Magnesium or Calcium peroxid may be used in conjunction with such organic acids as give rise to harmless soluble salts, thus:

$$2C_6H_8O_7H_2 + 3MgO_2 =$$
Citric Acid

$$Mg_3(C_6H_5O_7)_2 + 3H_2O_2$$
Magnesium Citrat

Sodium perborat ($NaBO_3$), when dissolved in water, forms the unstable metaborat ($NaBO_2$), which with the carbon dioxid of the water is converted into borax and sodium carbonat.

From Wiring Bells to Chief Electrician at $5200 a Year

What Men Can Do if They Master Electricity

Thousands of men have the natural born "knack" of understanding things mechanical. Without the slightest instruction, many of them have learned how to wire bells, and other simple principles of electricity.

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This young man realized that the opportunities in the field of electricity were as unlimited as the possibilities of electricity itself. He figured that the electrical profession was in its infancy in spite of the tremendous advancement that had been made in the past few years. He found that there were unlimited possibilities for positions which would fit any degree of ability he attained. He studied the problems of electricity in his spare time and soon became switchboard man for a telephone company. In a few months, he became Exchange Manager, and later Wire Chief. Leaving the telephone field, he engaged in central station work as an electrician, and was appointed operating engineer. A short time after that, he was appointed Chief Electrician at a salary of $5,200 a year.

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$NaBO_3 + H_2O = NaBO_2 + H_2O_2$
$4\ NaBO_2 + CO_2 = Na_2B_4O_7 + Na_2CO_3$.

By using 14 grams of perborat for each 100 cc. of water, a 10 volume hydrogen peroxid solution is obtained.

For preparing the medicinal solution of hydrogen peroxid, barium dioxid is first hydrated:

$BaO_2 + H_2O = BaO(OH)_2$

by slowly adding to it about double its weight of distilled water, ice cold, and, after standing about 30 minutes, either phosforic or sulfuric acid with water is gradually added with constant stirring, keeping cold by employing ice, until the mixture remains slightly acid. It is then made neutral by adding more of the dioxid.

Properties:—

Physical:—It is a nearly colorless (slightly blue in quantity), syrupy liquid.

It possesses a metallic, corrosive taste, and pungent odor.

It is miscible in water.

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It volatilizes at about 84 degrees F.

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$$2H_2O_2 = 2H_2O + O$$

Explosion of concentrated solutions may also be caused by the introduction of solid matter or finely divided platinum, iron, magnanese oxid, or carbon.

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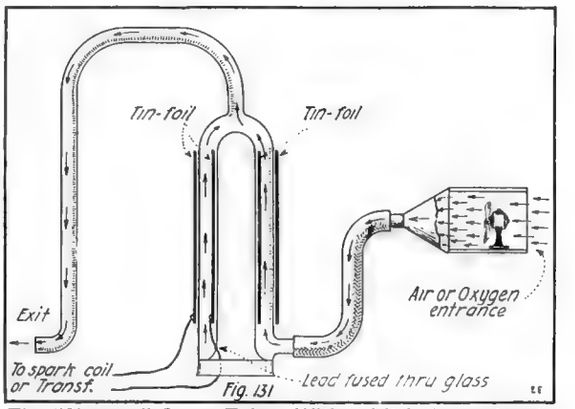

The "Siemens" Ozone Tube. With a Little Ingenuity the Experimenter Can Make One of These from Two Glass Test Tubes Cemented Together.

It also reduces, as well as oxidizes and is a powerful disinfectant and germicide.

USES.

The chief use of hydrogen peroxid is as an *antiseptic and germicide*. While this is by far the most important use, the solution is employed sometimes by artists to renovate old paintings. Its oxidizing action adapts it as a bleaching agent for cotton, wool, silk, ivory, hair, oils, etc. It is also used for sterilization and preservation of foods. It is employed in photography to remove the last traces of "hypo" from prints.

Tests:—

Upon the addition of hydrogen peroxid to a dilute solution of potassium iodid con-

UNCLE SAM WANTS OPERATORS

BOTH

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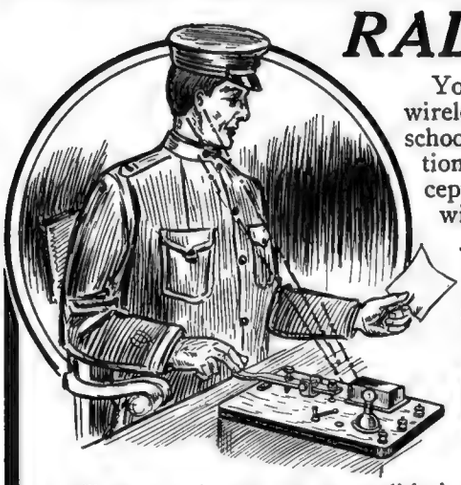
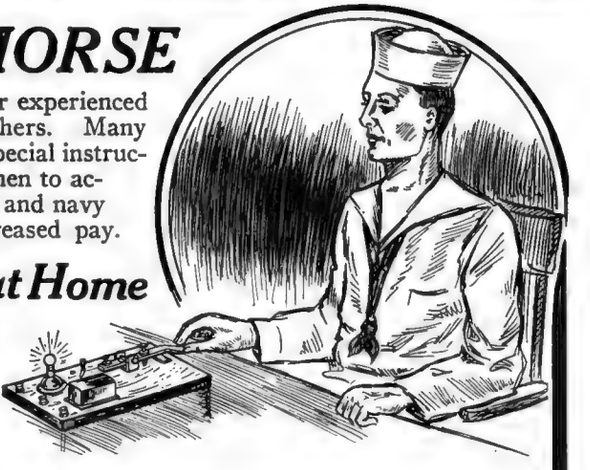
Your Government is calling for experienced wireless operators and telegraphers. Many schools have been opened where special instruction is given qualifying young men to accept such positions in the army and navy with advanced rank and increased pay.





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taining starch, and a few drops of ferrous sulfate, a blue color will appear. The ferrous salt is oxidized to the ferric state, which in turn liberates iodine from the potasium salt, to form starch iodid.

If a few drops of chromic anhydrid (CrO_3) solution, or potassium bichromat with sulfuric acid, are added to hydrogen peroxid, a blue color (of perchromic acid, H_3CrO_8) is obtained, which dissolves upon shaking with ether, with a blue color.

Ozone

HISTORY.

When a static electric machine is in operation, a peculiar and characteristic odor is present. It is also observed, to a slight extent, in the air after a lightning stroke. Van Marum, in 1785, described his observations, and that he had obtained the same odor in the gas given off from the anode when acidulated water was subjected to electrolysis. Schönbein applied the name *ozone,* signifying *a smell.*

PREPARATION.

Ozone is evolved at the *positive pole* in the electrolysis of water acidulated with either sulfuric or chromic acid.

It is also formed by the silent discharge of electricity thru air or oxygen. Fig. 131, shows a tube known as Siemens Ozone Tube" consisting of a glass tube covered with tinfoil, which is placed inside of a larger one covered on the out-side with tinfoil. The outer and inner coatings are connected to an induction coil while a current of air or oxygen passes thru.

It is also obtained when phosforus is permitted to slowly oxidize in the air, or when oxygen is past over pieces of moist phosforous.

PROPERTIES.

Ozone is a colorless gas with a peculiar odor, such as is noticed about moist phosforous. It reverts very gradually into ordinary oxygen, which change is hastened upon heating. Ozone dissolves readily in the volatile and fixt oils, and at 12 degrees water dissolves one-half volume of the gas, which solution is gradually converted into oxygen and hydrogen peroxid, thus:

$$H_2O + O_3 = O_2 + H_2O_2$$

It bleaches organic colors, such as indigo, litmus, etc., phosforus, sulfur, arsenic, and all metals, excepting gold and platinum, are converted into their respective highest oxides, ammonia being oxidized to ammonium nitrat. Silver is blackened thru the formation of black silver peroxid, and lead sulfid is converted to lead sulfate.

Detection:—

(1) Paper moistened with potassium iodid solution and starch paste turns blue when exposed to an atmosphere of ozone, thus:—

$$2KI + H_2O + O_3 = O_2 + 2KOH + I_2$$

Other oxidizing agents, as chlorin, bromin, nitrogen dioxid, also produce this reaction.

(2) Paper impregnated with a tincture of guaiac, and moistened with water, turns blue.

(3) The bright surface of silver is blackened by ozone; no other oxidizing agent producing this effect.

(4) Paper moistened with a solution of tetra-methyl-diamido-diphenyl-methan in acetic acid, gives a violet color with ozone; yellow with nitrogen dioxid; deep blue with bromin or chlorin; and no color with hydrogen peroxid.

Uses:—

Ozone is employed in industrial bleaching processes; for the destruction of fusel oil in alcohol; for the cleansing of wine and beer flasks; and, for the sterilization of water.

(*To be continued*)

Strongfortism Judged by Results

LIONEL STRONGFORT

The world's strongest and most perfect athlete, whose unaccepted challenge of competition to the greatest living "strong men" still stands.

BROUGHT to its final analysis, every system of healing must be judged by the results it produces. I have been acclaimed the most perfectly developed man by competent authorities. I am the product of the system I teach. Thousands who have followed my teachings have overcome weaknesses, eliminated disease and attained health after all other means had failed. I have learned from Nature the secret of reaching, strengthening and developing the internal muscles which control the function and nutrition of the vital organs. This enables the system to throw off impurities and disease. Thousands of my pupils have voluntarily written me of the wonderful benefits they have received. Here are a few of their letters:

The depressing mental symptoms of auto-intoxication disappeared from the beginning of your Course. My color is now as it should be. My **surplus adipose has all disappeared.** I act and feel like an entirely new person, and my **rupture is entirely cured.** My truss has been discarded since the third week of your Course. Considering the handicaps of abdominal adhesions which I had and the fear of attacks which hung over me and the limited exertions which I was able to make in the beginning, I consider the results truly remarkable.
Drifton, Pa. Cornelius B. Kunkle.

I have **gained eleven pounds. My nervousness has entirely disappeared,** my strength has increased five fold, **grown three-quarters of an inch** taller and my shoulders have broadened out. My mental energy has increased wonderfully; I never feel tired; am full of "pep" all of the time, and last I am much happier than I used to be. I might add that I eat about half the food that I used to. I'll stick to Strongfortism as long as I live.
Harold McCullough.
262 Main St., Petaluma, Cal.

Oh what a change. My face is no longer greasy and has lost its sallowness, pimples, boils and blackheads. Am rapidly taking on the healthy look and color. **My eyes are getting stronger.** Another thing I have noticed is my disposition; before starting with you I went to work with a grouch, now it is quite the reverse. I go to work whistling and humming, and could shout for the pure joy of living. All this is due to your efforts, for which I thank you. F. A. Hall.
85 Mt. Royal Ave., W., Montreal, Can.

Is it so, or am I dreaming? Here are some of the results that are undeniable. I have the **finest bowel action that I remember in years,** every day sure "fine and easy as you say, 2 each day." I don't have to arise at night any more to urinate since starting with you. Before it was a nightly occurrence, and sometimes two or three times. I sleep well now, and the beauty of it is that I am waking up more refreshed in the morning than for years. Every time I get through with the lessons I feel like a young horse turned loose and then I have more Eye-Pep-Nerve, it seems like, since I was a boy. I am actually getting young again. I am amazed, delighted, at the improvement.
O. M. Mitchell.
Y. M. C. A., South Bend, Ind.

I was down and out when I started your Course 6 weeks ago. **My interest in life is returning.** I have clearly demonstrated my increased efficiency by vastly improving the production records where I am employed, and am accomplishing twice as much work as I used to. I have confidence in myself now.
Willis A. Casey.
12½ Tafts St., Cambridge, Mass.

I have gained in development, muscles are firm and **skin is cleared** of all pimples. I feel a different man, resolute, able to meet the world. I will do my best to imbue other weaklings with the great blessings to be obtained through Strongfortism.
George Fair.
Centerton, Ind.

I have improved wonderfully in every corner of my body and have shown a **big increase in chest expansion.** I am perfectly satisfied. I have **gained fifteen pounds** and feel **one hundred per cent. alive.**
Rudolph Gross, Jr.
15 William St., New York City.

I don't know what to say to justify the condition I feel I am in. Never even as a boy have I possessed such **wonderful feeling of vigor and strength** as I do now.
Henry B. Freeman.
211 Clinton St., N. Y. City.

I want to say that your **Course has done me a world of good.** I wish I had known about it years ago. I am a happy man today.
Henry Flater.
1121½ Jackson St., Seattle, Wash.

Y. M. C. A. With the Colors.
Some time ago I bought a Course you had made up for me on increased height. It certainly has done the work. So far I have **gained 2½ inches.** Yours truly.
Chas. H. Runkel.
Camp Meade, Maryland, Md.

Your Course has done for me what you claimed it would: strengthened me both physically and mentally. It has put me on the **right road** to MANHOOD, and good living. I shall never indulge in that HABIT again. Thanking you a thousand times. Yours,
(Name Withheld on Request.)
Watertown, N. Y.

I have not a bit of trouble from indigestion or constipation now, and am 2 pounds heavier than I was three weeks ago.
Alliance, Nebr. Boyce Hamilton.

I feel **100% better** now. The quality of the muscles has improved very much. A. J. Loyka.
Cedar Rapids, Iowa.

Before taking your Course I was a physical wreck. You have done wonders for me. I have **passed the examining board for Military Duty as physically fit.** Leave for camp in a few days.
Willis E. Bacheller.
Jennings, La.

Since I joined the army, where you have to look out for yourself, I have found that the training I had from you has put me in a place where I can TAKE CARE OF MYSELF. When they ask me where I got my **strength** from I say, from the **finest man** I have ever seen, and that is **Lionel Strongfort,** and I believe you are for I was under two physical culture directors before I took your Course.
Pte. Joseph Atherton.
On Active Service, American Exped. Force, Feb. 24, 1918.

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It is an axiom in law and science that the testimony of several reliable witnesses establishes a fact. The FACTS in regard to Strongfortism have been proven beyond all question by thousands of witnesses. If your life is a burden because of weakness, or you are hampered as the result of disease, let the above letters, the sincere expressions of grateful hearts, point you to Strongfortism—your Salvation. Take heart. Nature cannot fail.

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The most important point is that the telephone receiver spool comes already wound complete, and the Experimenter will, therefore, not need to wind his own spool.

The outfit when assembled comprises a highly sensitive **CARBON GRAIN MICROPHONE** with carbon diaphragm of exactly the same type as is used with our **$15.00 Detectiphone.** (See our Cat. No. 19.)

The receiver is a special low resistance double pole type with the difference that no magnet is used in the same for the reason that the function of this instrument is electro-magnetic, the same as all loud-talking phones.

The spool is wound with special enamel wire for five ohms, standard with our **Detectiphone.**

This instrument works best on four dry cells, and particular attention is called to the fact that in order to work, the loud-talker requires a fairly heavy current and for that reason thick wires must be used for connecting the transmitter with the loud-talker. If this is not done, the voice will be weakened considerably. If no heavy wire is at hand, more batteries must be used to compensate.

USES: This instrument can be used to transmit phonograph music from one room to another; used as a Detectiphone; as a Radio Amplifier; as a telephone extension (by placing the regular telephone receiver against the sensitive transmitter with the loud-talker); for salesmen to talk "through" window (Loud-Talker outside in street, microphone transmitter for salesmen, talking into same); for restaurants for talking to the chef, and a hundred other uses. Many young experimenters are developing a lucrative business selling this appliance to various merchants at a good profit.

Outside of the two instrument parts, one three-foot cord is furnished with sensitive microphone as shown; instructions, etc., are furnished.

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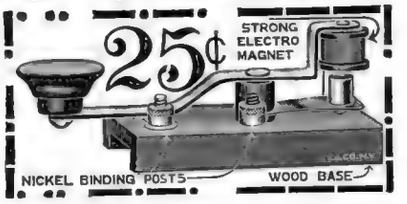

If the telegraph does not come up to expectation will cheerfully refund money. **Boys order 6 to 25 of these instruments. Sell like hot cakes to friends for 30 to 40 cts. each.** So small can be slipped into pocket. LEARN THE CODE DURING SPARE TIME. TELEGRAPH OPERATORS ARE SCARCE. UNCLE SAM NEEDS THOUSANDS.

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E. E. 9-18B

The Einthoven Galvanometer, Its Theory, Operation, Construction.

(*Continued from page* 319)

No. 30 drill, and are used to take out the leads from the winding. The core between the bobbin ends is carefully shellacked and covered with two layers of paper for insulation. The bobbin is then wound evenly, full with No. 24 double cotton-covered magnet wire. The leads are carefully removed from both ends and properly secured so as to prevent them from breaking off at the ends. The magnet yoke 3, is made from wrought iron bar and its lay-out is given in Fig. 7. It is very essential that the drilling should be very accurate and dimensions carefully followed, as the accuracy of the whole instrument assembly depends upon the drilling of these few holes. After the coils are wound they are then set in the respective holes in the yoke and firmly secured therein by set screws or by a close fit.

The active magnetic pole pieces 5, 5, are used for concentrating the magnetic field in the string region, and Fig. 8 shows their construction. They are also made from soft wrought iron. Altho their shape may seem peculiar, yet it was found thru actual test that the magnetic field was strongest with this type of construction than with any of the others that were tried. These pole pieces are fastened to the electro-magnet pole pieces by means of 8-32 set screws as noted. Two auxiliary pole pieces 6, 6, are used to increase the magnetic path service and also as a means of supporting the viewing telescope. Their details are given in Fig. 9. The telescope hole is drilled to receive a three-eighths inch tap. This should be of No. 40 pitch thread.

The movable wire-supporting stand 7, is made as shown in Fig. 10. It is composed of a solid brass rod three-quarters of an inch in diameter and cut to size with two 8-32 tap holes at each end as indicated. This is secured to the wood base, and a projecting arm 8, Fig. 11, is used to support the wire containing tube 10. It is made from stock brass measuring 3-5/8x7/8x3/8", and two holes are made at each end, one ½" and the other with a No. 18 drill, as shown in the figure. A tension controlling tube 10, is inserted in the ½" hole, and this is made as indicated in Fig. 12. The 4-32 tap hole is used to secure a notch piece, Fig. 13, to prevent the tension rod Fig. 14, from turning when it is tightened or released. This rod is made from a No. 10 brass rod. One and one-half inches from the end, cut a three-sixty-fourth inch slot, three-sixty-fourths of an inch deep. This can be done easily without either a shaper or milling machine, by taking two hacksaw blades, and securing both of them in the hacksaw frame. Care should be taken that the teeth of both be in the same direction. The rod should be firmly secured in a vise.

(*To be continued*)

Material of Fibre	Diameter of Fibre	Resistance in ohms	Period in seconds	Magnification	Deflection in mm. per micro-amp	Deflection in mm. per micro-volt	1 mm. defl. produced by micro-amps.	1 mm. defl. produced by micro-volts	Factor of Merit*
Silver wire	0·020 mm.	4·7	—	500	4·4	0·94	$2·3 \times 10^{-1}$	1·07	—
Silvered quartz fibre	0·002 mm.	20,000	—	500	62,500	3·13	$1·6 \times 10^{-5}$	$3·2 \times 10^{-1}$	—
" " "	0·003 mm.	6600	—†	650	333,000	50·5	3×10^{-6}	$1·98 \times 10^{-2}$	—
" " "	0·002 mm.	5860	0·008	750	30	0·005	$3·3 \times 10^{-2}$	2×10^{2}	117,000
" " "	0·002 mm.	3890	0·005	750	9·7	0·003	$1·03 \times 10^{-1}$	4×10^{2}	117,000

POPULAR DEMONSTRATION OF THOUGHT TRANSFERENCE AND OTHER PHENOMENA.

(*Continued from page* 304)

To note the action on the pulse over a great distance, suspend a coil of wire from a room fixture (aerial) and to the latter connect a wire (see experiment III and Fig. 3) with the pit of the stomach of percipient (over the clothing). If the agent executes willing at a distance (in the percipient's direction) the latter may be informed over the telephone the moment he wills by another who announces the fact the moment the pulse of the percipient is retarded.

I have successfully conducted this interesting experiment at a distance of 41 miles.

EXPERIMENT II.—*Showing the effects of concentrated thought.* When sudden concentrated thought (arithmetical problem) is executed, some agents may influence the pulse but all may do so if RED MATERIAL is placed on the agent's head.

Note the influence of different colors on intense thought or willing by the agent. RED and YELLOW increase and PURPLE decreases the effects on the pulse.

EXPERIMENT III.—*Showing that concentration of the mind is literally true.* To prove this brain focusing, let the agent concentrate the mind on one of several wooden or paper objects in the room. One end of a

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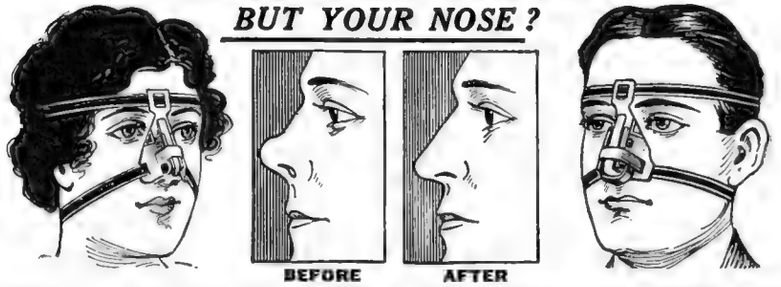
BUT YOUR NOSE?



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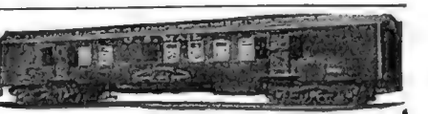

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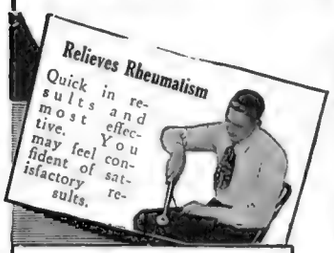

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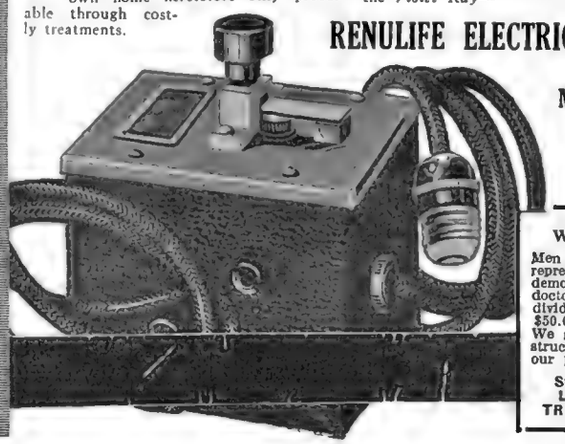

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wire* (A) is connected with the percipient and aerial and another wire (B) is connected to the aerial (Fig. 3).

Fig. 3.—Showing connections of wires A and B. A, is connected to aerial and stomach of percipient and B, to aerial with one end for touching objects or for use in studying gravitational energy. Wires may be hooked directly to a fixture.

An independent person now touches with the other end of wire B, the several objects in succession. The moment the object on which the agent has concentrated is touched, the effect on the pulse may be noted. Permit the wire to remain in contact with each object for several seconds.

EXPERIMENT IV.—*Proving that good thinkers use two sides of the brain and that ordinary thinkers use only one side.* Genius is a matter of bicerebration. Use two wires as in experiment III. While the agent is engaged in some mental arithmetical problem (addition or multiplication), an independent person places one end of the (B) wire in contact with one side of his head (5 inches) directly above the extreme upper end of the ear). If there is no pulse response try the other side. Note that, in the good thinker, there is a pulse response from both sides of the head whereas in the ordinary thinker, the response is from one side only.

EXPERIMENT V.—*It is said that the secret of gravitation is the greatest problem still unsolved.* Prove the correctness of the author's theory, *viz.,* that, A gravitation is an electrical attraction and that the ether is in itself an electrical charge of positive and negative electricity; that B the ether's composition is derived from the radioactivity of all substances in the universe.

Use two wires as in experiment III. Place wire B on the floor and note each time a heavy body is raised, the effect may be noted on the pulse. The shearing of the ether's electricity into positive and negative may be demonstrated by bringing the end of wire A in contact with the VAGUS NERVE (instead of pit of stomach) as in experiment VII.

Note that, by the latter maneuver, at the center of gravity of the raised object, the electricity is negative and positive, on either side of the gravitational center.

EXPERIMENT VI.—*Showing that personal magnetism has a literal significance. That radiations are constantly emanating from our bodies and that temperamental individuals discharge radiations of great intensity. That the "laying on of hands" in the cure of disease is not mythical. That telekinesis (movements of objects without contact with the mover) is a reality. That the effects of human energy may be exerted at a greater distance in a dark than in a light room. The latter fact explains why in materialization, a dark séance room is demanded for better propitiation of the spirits.*

Prove that telekinetic and kindred phenomena are dependent on a compound of the elementary consciousness of the "sitters"; each sitter enters as a dynamogenic element (production of nerve force) in the production of energy.

Approach the percipient with the extended fingers of one hand directed toward the pit of the stomach. Note the retardation of the pulse. Note that temperamental persons can exert this action at a great distance whereas others can only do so when the finger tips are almost in contact with the pit of the stomach of the percipient.

Note that when the finger tips of both

*With all experiments with wires A and B, the latter should be insulated, excepting at the ends in contact with aerial and pit of the stomach of percipient. It can be fixed to the latter with a cord (over clothes), fastened to the skin with plaster or held by an assistant in such a way (also wire B) that the insulated portion of the wire is grasped with the finger ends directed away from the pit of the stomach (Fig. 3).

hands are extended at the latter site, no effect on the pulse can be noted until one hand is removed. The human is essentially a battery, from the finger tips of one hand positive electricity is discharged and from the other hand, negative electricity. One electricity neutralizes the other and there is no energy evolved until one hand is removed.

The radiations from the hand cause a contraction of the heart (reflex) which is practically telekinesis on a small scale. Note that, with subdued light the energy from the finger tips, has a more accentuated action on the pulse at a further distance than in the light.

Man is a transformer of energy which he receives from his environment. Note that the pulse effects are greater after exposure of your body to an intense light or a current of electricity than before.

Note that when several persons grasp hands and one of the persons presents the fingers of his disengaged hand at the pit of the stomach of the percipient a greater affect is noted.

EXPERIMENT VII.—*Showing that polarity is not the exclusive prerogative of magnetic materials.* On either side of the wind-pipe in the neck, (Fig. 4) are the right and left pneumogastric nerves. When these nerves are stimulated, the needle movements show less amplitude and when they are deprest the movements show greater amplitude.

Fig. 4.—Lines indicating the site of the right and left pneumogastric nerves.

Take a bar-magnet (held at end with fingers at right angles and directed at a right angle) and note the following effects on the amplitude of the needle:

MALE.

Right Pneumogastric Nerve—	
Positive pole (N)	Increases amplitude
Negative pole (—)	Decreases amplitude
Left Pneumogastric Nerve—	
Positive	Decreases amplitude
Negative	Increases amplitude

FEMALE

Right Pneumogastric Nerve—	
Positive pole	Decreases amplitude
Negative pole	Increases amplitude
Left Pneumogastric Nerve—	
Positive	Increases amplitude
Negative	Decreases amplitude

Note that the foregoing refers only to the normal male and female. If, in a male or female, the polarity is reversed, the male would react like a female and *vice versa.* Sexual inclination is a matter of polarity and its determination may thus be demonstrated. A mistake in your deduction is a serious matter. Note that the extended finger tips of the right hand of a normal male directed to the pneumogastric nerves act like the positive pole of a bar-magnet whereas the fingers of the left hand act like the negative pole of a like magnet. The opposite holds good in a normal female. Note that YELLOW MATERIAL on the head or body of a normal male or female will reverse the polarity of their finger tips. That is, the male will show female and the female, male polarity.

COLOR may thus influence sex tendencies. Show effects with the positive or negative end of any dry cell like with the magnet.

Many other interesting experiments will suggest themselves to the interested experimenter. Remember, however, that the most mystifying phenomena rest upon the least complex causes; and the simpler a thing is, the harder it is to understand. Observe all the details as suggested. To demonstrate phenomena which have heretofore baffled the scientific world is at least worthy of patience.

THE GYRO-ELECTRIC DESTROYER —ONCE MORE.

(*Continued from page* 313)

I urge you to make the attempt. You have the journal, and it won't cost a whole lot to make the attempt. The result might astound you, and if our joint efforts could shorten this struggle one month even, the money would be well spent.

Why not go to it?

CHARLES S. WOLFE,
1200 Stambridge St.,
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All of the letters received read practically alike, but the strangest part about the whole matter is, that altho in correspondence with certain U. S. Senators, to whose attention I had brought the Gyro-Electric Cruiser, I had never thought about building a machine and subsequently turning it over to Uncle Sam.

But, EXPERIMENTER readers evidently know and sense more than I, with my nose to the everlasting grindstone, so if my reader-friends desire to wish a new job on me—well I can only say that they will find me ready.

It is quite an idea at that, and I am glad it did not originate with me. I'd much rather have the "other fellow" endorse the scheme.

Besides, Readers, wouldn't it sound good if, after the War, we could say, casually:

"The Gyro-Destroyer? Oh, yes! My dollar went into the *first one*—and that dollar proved SOME fighter!"

Here's my plan: A small model about 10 feet high will cost about $8,000, figuring materials, labor, engineers, shop equipment to build it, etc. A half "life" size model, (20 feet high) might cost as much as $20,000. But what is that for 100,000 readers? Let every reader send in his contribution of any amount he can afford and we will build whatever size model the total amount received enables us to. If every reader contributes $1.00 we can build a complete and full size Destroyer to turn over to Uncle Sam. It is self-understood that I must account for every cent taken in as well as spent. Each contributor's name will be printed in the magazine, as well as a final statement showing how the money was spent. If less than $5,000 is taken in the money will be returned to its owners. If a sufficient amount is collected a real working model will be built as fast as it is possible, while EXPERIMENTER readers will be kept informed as to the progress of the Destroyer.

As soon as it is completed it will be formally turned over to the War Department in the name of the readers of the ELECTRICAL EXPERIMENTER, while a printed list giving the names of the contributors will be furnished the officials at the same time.

Now you know the arguments of the case. Judge for yourself. But before I close remember that in the February issue, for military reasons, I did not divulge certain important features which tend for great efficiency of the destroyer. I furthermore did not divulge a very important protective feature, to prevent the Destroyer from being bombed from aeroplanes above. All of these features would of course be incorporated into the model, and as we would no doubt be able to obtain Government sentries to protect the shop while the model was being built, there would be little chance of important information leaking out.

Now, the Gyro-Electric-Destroyer is in your hands. I am not going to annoy you with a stereotyped patriotic appeal urging you to sign the appended blank. As a matter of fact, I do not wish to urge you. It is entirely a matter of your judgment and whether you believe in the Destroyer.

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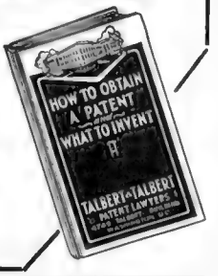

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PATENT

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In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries address to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

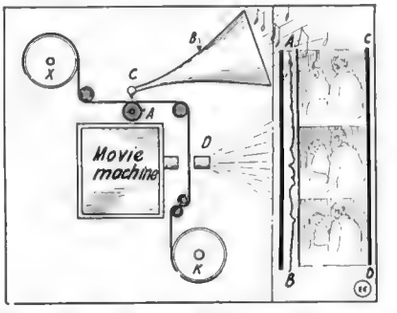
Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

Readers' attention is called to the fact that due to the great amount of letters to this department it is quite impossible to answer them all thru these columns. The inquiries answered in this issue date as far back as April, and if readers wish speedy service they should carefully note the announcement appearing in the preceding paragraph.

Talking Moving Pictures.

(253) Douglas C. McCall, Opelika, Ala., submits an ingenious scheme for talking moving pictures, and the idea is apparent from our illustration.

As it will be seen, Mr. McCall wishes to utilize the celluloid film for two purposes, namely, for the registering for the film itself as well as the registering of the voice. In a former issue of the ELECTRICAL EXPERIMENTER there was described a scheme of a New York inventor, showing how a plurality of phonograph records could be registered simultaneously on a celluloid film. Mr. McCall makes use of the same idea, except that he incorporates it in connection with talking moving pictures.. From our illustration it will be seen that X and K are film reels. A is the roller over which the film passes. C is a sounding box, and B reproducing horn; D point where film passes before lens, throwing picture on screen.



New Talking "Movie" Scheme Having Voice Record on Same Film with Pictures.

A. To our mind this is a very good idea, altho it probably will be found that a special phonograph is required as well as a steadying device. We also would think that a microphonic reproducer instead of a mechanical one shown at C would be preferable. We believe the idea is patentable.

War Tank.

(254) Kenneth Harlan, Albany, N. Y., wishes to know if a patent has been issued on a small war tank which operates the same way as the big tanks, power to be furnished by a small motor or clock work.

ADVICE

H. GERNSBACK

A. Nothing of this kind is patentable. We presume our correspondent refers to small trench tanks which are sent out over "No Man's Land," the motion being controlled by a cable or wire. Quite a good many schemes of this kind have been proposed, but unless there are unusually new features connected with it, we doubt if a patent could be obtained.

Linotype Gas Lighter.

(255) Walter Lichtenberg, Tacoma, Wash., submits a diagram and sketch of an electric automatic linotype gas lighter, the idea being to have it controlled by a clock so that the gas could be turned on at a certain pre-arranged time in order that the linotype operator would not have to wait until the metal is melted.

A. This scheme is very clever, but we are quite certain that no patent can be obtained because there are no new functions contained in this idea. It is merely an adaption of well known as well as old principles towards something that may not have been done before.

Phonograph.

(256) J. Brewton Berry, Orangeburg, S. C., thinks he has an idea whereby the volume of a Victrola can be greatly increased and the music be made more distinct. He thinks that by attaching a small piece of isinglass or some such material to the arm to which normally the phonograph needle is attached, the sound will be greatly increased.

A. From the sketch and description which accompanied this article, we fail to see why a greater volume of sound should be obtained by this means. All phonograph sound boxes use a mica disc for reproduction.

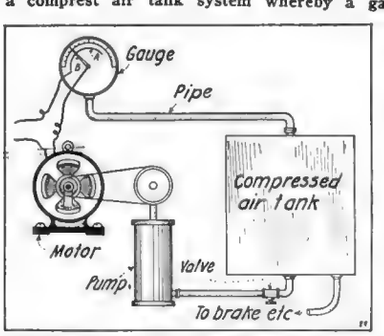
Street Car Indicator.

(257) Gerald Lyons, Cleveland, Ohio, submits diagram and description of a street car indicator. The idea is to have a ratchet wheel strike at a protruding notch placed on the rail. Every time the ratchet wheel hits this notch, a drum will be advanced which shows the street indicated.

A. There is nothing intrinsically new about this idea, and the worst feature about this is that schemes of this kind have always been looked upon with great disfavor by the traction companies, for the reason that anything that tends to interfere with the regular operation of their standardized equipment is not popular. It would also be more or less dangerous for vehicular traffic, to have an abundancy of notches of this kind on rails going thru streets, etc.

Air Compressor.

(258) G. Clarke, Toronto, Can., submits an idea of a comprest air tank system whereby a gage



Automatic Air Compressor Gage-Switch Which Cuts Off Pump Motor as Soon as Pressure Exceeds Certain Value.

GOVERNMENT TO CONTROL ALL WIRE SYSTEMS.

A bill to authorize the government during the war to take over control of all telegraph and telephone communication, cables and wireless stations, was recently signed by President Wilson.

The Nation's communication lines went under Government control on July 31. It is reliably reported that the control will include telegraph, telephones and cables. The radio systems of the country already are under Government supervision.

ELECTRIC FURNACE TO MAKE WAR ALLOYS.

Plans for the erection of an electric furnace in Spokane, Wash., for the production of alloys for war uses, on a site to be furnished by the Washington Water Power Company, which is also to furnish the power for the experimental purposes, were discust at a recent meeting held under the auspices of the industrial committee of the chamber of commerce. Those present pledged $1,000 toward the $2,000 needed. Washington State college has pledged $500.

As a symptom of the recent rapid development of Japan's commercial interests in Shanghai, Japanese lighting interests are now supplying a large proportion of the electric lamps for the city which were formerly imported chiefly from the General Electric Company in America. The fact is pointed out in the report of the Japanese consul-general at that point.

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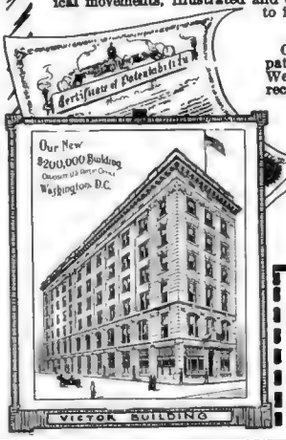

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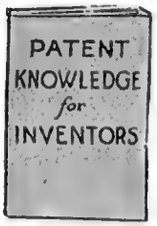

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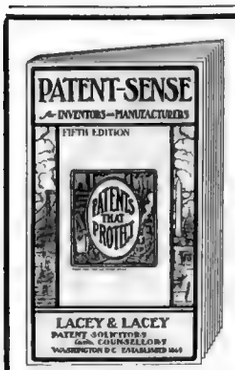

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automatically cuts off the electric current from the motor as soon as the pressure becomes too high. This scheme is readily understood by studying the attached diagram. Our advice is asked as to patentability, etc., and if the scheme is feasible.

A. While the specific means to cut off the current as shown in the diagram is new, the general underlying principle is quite old, as nearly all compressors work on a principle of this kind, particularly those used on elevated and subway trains. Usually a gage is made use of which has a diafram, the latter, when expanding, makes or breaks the contacts. It appears to us that the scheme as outlined by our correspondent seems somewhat more complicated than the existing means of this kind.

Bicycle Brakes.

(259) G. L. Kochis, Braddock, Pa., writes as follows:

I have an idea for an emergency brake to be used on a bicycle. By pressing a lever the rim of the front wheel is tightly clasped. Such brakes could be made and sold for 25 cents.

A. There is nothing new about an idea of this kind, quite a number of bicycle brakes of this sort being in existence now.

Propeller.

(260) P. C. Sauther, Brooklyn, N. Y., writes as follows: Enclosed you will find description and sketch of a new propeller on which I greatly desire your advice. As you will notice the improvement is merely in the arrangement of the blades. The propeller now universally used, if revolved too quickly, would "churn"—that is, one blade merely opening up the water for the next blade to pass almost entirely thru empty space, besides the loss of slippage, which varies from 15% to 30% in all propellers now used.

You will note that besides each blade individually screwing itself thru the water the arrangement of the blades also forms a screw. The distance between blades would, of course, vary with the pitch of the blades.

Not only, in my opinion, will this increase the speed of a ship but will save that energy which now goes to waste in slippage due to the inefficiency of the present propeller.

A. This is a good idea but we doubt if anything in the propeller line of this sort is patentable. The most you can get is the so-called "Design Patent," which would not afford you much protection.

Ship propellers have been brought to the highest pitch of efficiency in the past forty years and we are almost certain that an idea of this kind must have been tried before.

EXPERIMENTAL PHYSICS.

(*Continued from page* 315)

Bend a piece of No. 14 copper wire (b) in the approximate shape of a circle (see Fig. 82-I). Suspend it by a fine thread (a) so that the ends dip into mercury troughs in block of wood (d). The mercury troughs are connected to the binding posts P and P^1; on passing a strong electric current thru the wire we find that it slowly but surely (the speed depending upon the strength of current) turns so as to assume an East-West position. This is identically what would happen if we were to suspend freely a magnetized circular disc. It would assume an East-West position in order that its magnetized faces might point in North-South direction. Hence we conclude that A CIRCULAR WIRE CARRYING A CURRENT ACTS AS A MAGNETIZED DISC.

Let us apply the *right-hand* rule. If the current is traveling in a counter-clockwise direction, (as in figure) upward at the left and downward at the right; the rule applied to either the left or right gives the same result, i. e., the face of the "disc" (Fig. 82-I) towards us is "S" and the face away from us is "N" and the lines of force go from us into the plane of the paper. In Fig. 82-II, the rule gives us N at the right and S at the left, i. e., the lines of force are from left to right. We found that the loop turns to an East-West position. It is important to note that the loop in turning to this position TURNED SO AS TO INCLUDE AS MANY AS POSSIBLE OF THE LINES OF FORCE OF THE EARTH'S MAGNETIC FIELD.

EXPERIMENT 92—Bend an insulated wire in the form of a helix. Pass a current thru it and bring the helix near a compass (see Fig. 83-I). We find that the compass needle behaves just as if the helix were a bar

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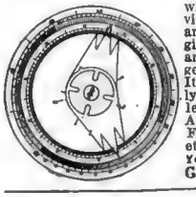

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magnet (see Fig. 83-I). (See Lesson 12.). We could easily have predicted this result for can we not consider the helix to be many of the discs of the preceding experiment placed together? When this series of discs are placed side by side all the poles are neutralized except those at the two ends; since in the other cases a N pole is in contact with S pole. This is obviously analogous to a bar magnet. The right-hand rule slightly modified as follows is convenient in determining the direction of the field of a helix, knowing the direction of the current and vice versa. GRASP THE HELIX IN THE RIGHT HAND SO THAT THE FINGERS ENCIRCLE IT IN THE DIRECTION IN WHICH THE CURRENT IS FLOWING IN THE WIRE. THE THUMB THEN POINTS IN THE DIRECTION OF THE NORTH POLE OF THE HELIX. IF THE HAND IS PLACED SO THAT THE THUMB POINTS IN THE DIRECTION OF THE NORTH POLE OF THE HELIX, THE FINGERS WILL SHOW THE DIRECTION IN WHICH THE CURRENT IS FLOWING. (see Fig. 83-II). The writer suggests that the reader test himself on the knowledge of these important rules by *concealing the battery* so as not to know the direction of the current and determining the direction of current flow, and also by removing the compass and determining the polarity.

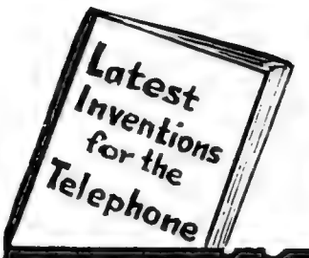
(*To be continued*)

GENIUS AND ULTRA VIOLET RAYS.

(*Continued from page* 296)

his imaginative power together with his cheerfulness. As the day declined his mental activity diminished until he fell into a lethargy which lasted to the following day." "Giordani could only compose in the sun, or in the presence of abundant light and great heat." There have been also many geniuses who could compose only in the presence of great heat. Sylvester, a great mathematician, tells how when on board the "Invicta" beneath the vivifying rays of a powerful sun, the method of solving a multiple equation occurred to him, and he succeeded without pen or pencil. Many other examples could also be cited but the reader can refer to them himself in many biographies.

We then see that not only is the sun the "all life giver" but that he has aided geniuses in their creative works by means of its ultra violet rays acting on the cerebral substance as stimulants.



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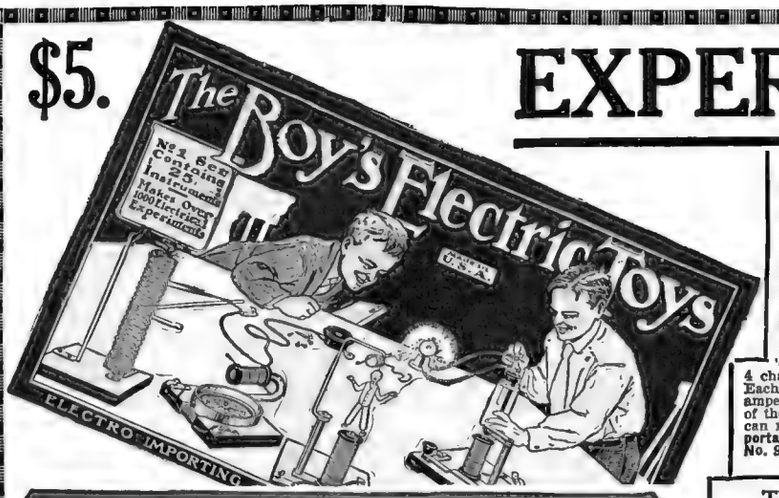

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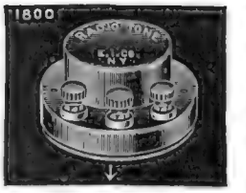

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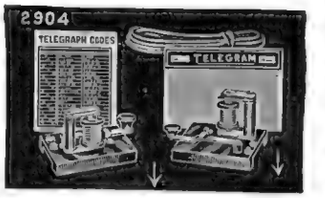

is not a toy, but a practical, honestly built telegraph outfit, which not only sounds but works like the big commercial instruments. By studying the code for 30 days you can become a first-class telegraph operator. Such operators are in big demand now. Outfit consists of TWO complete telegraph instruments each measuring 3½ x 2½ x 2¼. All metal parts are highly nickel plated, including key lever. Note hard rubber knob. Telegraph Code Chart, telegraph blanks and connecting wire comes with set, but no batteries. Outfit works on 2 dry cells (one cell for each instrument). The "Electro" is the ONLY Outfit that works both ways, each station can call; no switches, no extras. Nothing to get out of order. Guaranteed to please you or money back. **Price Complete as illustrated (TWO INSTRUMENTS).. $1.25**

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"OVER THERE"—A MINIATURE WAR PANORAMA.

(*Continued from page* 305)

of Robert Barker. He was a painter and teacher of drawing in Edinborough. One day it occurred to him as he stood on a height overlooking that city that he could make such an immense bird's eye view of it as to give a person standing at a point of vantage in the middle of a building a full idea of its immensity and all the details of its appearance. He first developed the idea by painting on slips of paper and mounting these on pieces of linen.

Then he went to London to submit his ideas to Sir Joshua Reynolds, then the centre of the artistic world. The latter pronounced it original, interesting but not practical, adding: "If you ever succeed in finishing it as you plan, I'll get out of bed any time to see it." Several years later, Sir Joshua did hurry from his breakfast table at the invitation of Barker to rush to see his original panorama of "The Battle of Waterloo." This was the first of a series of immense designs which the elder Barker created in the building especially constructed for him by Lord Elco on Castle Street, Leicester Square, London. Others were: "The Siege of Paris." "The Battle of Copenhagen," "The City of London" and the "Fleet at Spithead."

Robert Barker's work was continued by his son, equally distinguished in the field of the panorama. He was Henry Aston Barker, and the work of these geniuses was again continued by Robert Burford.

Hugh Thomas at Luna is imbued thoroly with the art of the creative panorama. His first big opportunity came to him at Luna. It was the creation of the "Submarine Attack," said to be the most effective indoor spectacle ever accomplished.

"Over There" is the actual depiction of the scenes back of the lines in Picardy. In it are a mass of details connected with the mechanism of war as now proceeded with. The gigantic task accomplished by our men over in France is carefully, almost reverently, set before the spectator. The bird's-eye view is scientifically followed and a zone of fire covering 1,000 *square miles* is laid before you. Your French villages are shown in the process of abandonment by the Germans. There is a river and the mountainous, forest-grown country of action is carefully depicted by this master of "war in the miniature."

Most interesting of all to the uninitiated would be the "spectacle" that goes on behind the scenes. Out front with the blare of trumpets and the 'bally-ho' the crowds assemble, then pass thru a true representation of the trenches "Over There"; and thence to their seats in the auditorium. The curtain falls (in this case it is more feasible to have the curtain fall) as therefore it gives one a chance to see things in a natural perspective. The distant scenery comes first to view and gradually draws nearer, showing the large shell holes and uptorn terrain. We see the ammunition trains at work and the Red Cross and the trucks, while close to hand are the Army Staff Headquarters with the sentries doing duty, *et cetera.* Then there is the great "battle" with the evacuation of the occupied area by the German Troops and its subsequent recapture by the French. Most beautiful, might be said to be the battle effects which are most realistic and inspiring; and taken all in all we who are "Over Here" may gain a tolerably good idea of what is doing on the other side of the Big Pond.

"Back of the Scenes" everything appears topsy tervy, especially to the layman, but to the initiated everything seems simple—everyone knows his place and all that is expected of him. There are rows upon rows of trees, houses and trenches arranged in the form of an amphitheatre and each row higher than the one before. In between are the various continuous chains which have attached to them soldiers, tanks, and army wagons and by an ingenious arrangement of the scenery it always appears as if a perpetual stream of them were coming and going.

Most marvelous of all is the clever electrical arrangement that regulates every performance to the same length of time and causing each succeeding incident in the living panorama to take place at the same instant in each showing. This is taken care of by a large drum having numerous electrical contacts arranged on its surface; see insert figure in the illustration. This drum is about five feet in diameter and is started by touching a switch, which is so arranged that it cannot be left shut and has to be held in position until a contact is reached on the drum which closes the circuit to the motor which keeps it running for the length of the performance, which lasts about twelve minutes. The drum makes just one complete revolution in the twelve minutes and about a minute and a half before the close of the show, the lecturer in the audience receives a warning signal which enables him to make his final speech. Just as he gets to the last word, the contact is closed for the raising of the curtain and the "show is over."

Another novel arrangement consists of a special battery of guns to give the effect of bombardments, explosions, etc. It consists of a series of large pipes about eight inches in diameter and about ten feet in height. The lower ends are sealed and at the top, in a horizontal plane facing forward, are inserted large funnels. By another automatic electric contact drum arrangement, as seen in the small insert, the firing of the miniature artillery is controlled. The plan on which they work is like this:—Illuminating gas is admitted thru a stop-cock in the base of the pipe to the inside; also thru another stop-cock comprest air is admitted. When it is near the time for the gun to "fire," these stop-cocks are automatically shut and the circuit closed to an ordinary auto spark coil which causes a spark-plug in the head of the pipe to ignite the mixture—giving "some roar" that would do justice to one of those 100 mile guns ! ! ! This process follows in regular order, viz: while one gun is being fired, another is filling with the mixture, while still another in being set ready to fire, etc. Add on top of this the fact that a dozen or so of big "forty-five" automatics are continuously popping off for the small arms effects, and you have as near to what Sherman said war was, as even the most zealous and fearless arm-chair patriot could desire.

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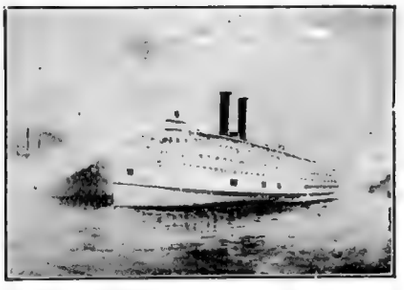

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producing pictures in their natural colors, and for many years made most exhaustive experiments to develop a theory which he had formulated when he first began this work. Success has been attained, and the pictures show how faithfully the invention is able to reproduce every hue, shade and tint of the colors of nature.

The process is not only practicable, but is comparatively inexpensive and simple. By means of a small and inexpensive color screen attached to any motion picture camera, several color values of the image photographed, are given to the negative, from which positive films are printed by a secret chemical process. A film is thus produced which contains a series of images so colored as to give, when projected, a moving picture in natural colors, without the use at all of the rotary colored shutter which is usually required. By this contrivance, the brilliancy and intensity of the projected colored picture is increased and a stereoscopic effect is obtained, impossible in black and white. There is no more light required than is used in projecting black and white, and a speed of only 24 to the second is required; thru certain experiments being made, this speed will be reduced. The cost of producing pictures by this process is slightly more than that for making black and white ones, while the advantage in the art of producing motion pictures is considerable.

The effects obtained are marvelously true to nature. The range of tint and hues unlimited. The presence of grays and neutral tints which are always present in nature, and which soften and tone down the harsh colors, are plentiful in these pictures. Thus, in addition to showing the vivid colors, all the delicate shades and hues of flesh tints, of clothings and draperies, of the gradually changing sky tints of sunrise and sunset, are reproduced with magical subtlety.

The author had the pleasure of seeing these new wonder pictures and they certainly merited the frequent applause, as each new possibility was unfolded on the screen. In order to bring out all the beauties of colors three scantily clad young women in Greek garb danced on a lawn, and the pictures showed wonderful coloring, the trees, lawn, bushes, and soft natural hues of the girls' complexions being beyond compare. Then followed the scenic wonders of Yosemite Valley, Yellowstone Park, Bridal Veil Falls and the recent bathing girl pageant at a southern California resort, all in natural colors.

MAKING SYNTHETIC GEMS IN THE ELECTRIC FURNACE.

(*Continued from page 297*)

so far they have been the most successful in this class of work.

The first amongst these is the resistance furnace with electrodes of grafite with the crucible placed between the electrodes and directly into the flame. Another way of making the synthetic gems is to have the electrodes set in a flaming arc of about 3,000 degrees Fahrenheit, and the ingredients are dropt thru the flame in one batch and caught in a crucible set underneath, the crucible setting in water so that the molten mass is suddenly cooled, thus obtaining the necessary application of extreme heat and rapid cooling with the attendant and much desired pressure.

Lately Dr. Aisen's son has been the discoverer and has actually made synthetic diamonds that bid fair to rival the genuine. The results have been the crowning effort of many years of painstaking research and investigation. The method of procedure is somewhat along the following order:

In a crucible set in the electric furnace is placed iron of the best grade which is

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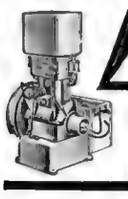

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super-heated until in a molten state. Then a pure grade of carbon is added and allowed to combine with the iron; when brought up to the desired degree the crucible containing the highly heated mass is plunged into cold water. As carbon is absorbed less in cold iron than in super-heated iron the action of the cooling of the mass serves to throw out the excess of carbon from the mixture. This carries, of course, some of the iron with it which forms around the edges of the crucible in the shape of diamond crystals. This is perhaps one of the greatest of all accomplishments in this field.

A very interesting procedure is the actual making of a synthetic jewel and the author had the good fortune to see the operation. One of the accompanying photos shows Dr. Aisen watching the slow process of the making of a precious stone as it grows gradually before the eyes. It is necessary to wear heavy goggles—dark ones of course—as the glare from the arc is very blinding. The component elements are contained in the cup at the top of the arc and every three or four seconds it receives automatically a slight tap which allows a very minute quantity to drop thru the hollow electrode and onto the stone that is in the process of making. The stone itself is perched on top of the lower electrode and the tapping process is controlled by a motor-driven arm.

In another view we see the bank of electric furnaces wherein the elements are placed in a crucible and then heated to the desired degree after which they are left to cool in the furnaces gradually. When cool the mass is removed and the solid chunk of glass, for that is what it resembles, is broken and then comes the final processes of cutting, grinding and polishing. In all of the methods used, it is necessary to go thru the usual routine of cutting, grinding and polishing, the same as with natural stones as found in the rough.

Numerous methods have been employed in the artificial manufacture of precious gems, which apparently sound very simple as explained here, but one must not forget that many years of patient laboratory research were first necessary, not to mention the study of numerous scientists who have devoted their lives in the search for Dame Nature's secrets. So that it is indeed wonderful as one stops to consider these beautiful man-made jewels, the product of the electrical furnace, the great stride made in the advance of the chemist's art.

THE PHENOMENA OF ELECTRICAL CONDUCTION IN GASES.

(*Continued from page* 314)

from the surface of the water W, and cooling due to the expansion causes this to condense. If neither ions nor dust are present no cloud will form, but if the chamber A is subjected to X-rays or an electric spark, a cloud will form, each little droplet condensing about an ion.

Prof. Millikan's experiment which is so often referred to, and which is probably the most accurate determination of "e" yet accomplisht, is really a modification of these earlier experiments, and instead of diminishing the credit due him, the cleverness of these modifications demands even more praise. Instead of calculating the charge of one ion from the charge of a large number, Prof. Millikan actually *isolated and measured a single ion,* and he used the smallest possible ion, a *negative electron.* He did this by letting a single drop from a cloud fall into another chamber, and he used oil drops instead of water so as to reduce evaporation, and enable him to examine the drop for a long time.

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The amount of electricity, or "e," he calculated by measuring how strongly it was attracted or repelled in an electric field of known strength.

Millikan's calculations of "e," give it the value 4.77×10^{10} electro-static units of quantity. The mass can now be calculated and for *positive carriers* it comes out the mass of the appropriate atom present. For negative carriers whose value of e/m is 10^7 it is different, however, and the mass "m" comes out about 1/1,800 that of the lightest hydrogen atom. This then is the electron.

In making such measurements as these frequent variations were found in the *mass.* Now the mass of any object is defined by its inertia or property of resisting motion. It has long been known that an electric charge possesses inertia and the question now arises as to whether the inertia of an ion is due to its electrical charge or to something else more material on which the charge exists, or to both. Some experiments by Kaufmann on this subject show very conclusively that the *mass varies with the speed,* and he was first tempted to think that perhaps a third or a fourth of the mass was due to electricity alone. He observed the charged particles given off by Radium, some of which approach the speed of light and some of which are much slower. By mathematical interpretation of these and other data J. J. Thomson and others have shown that *all* the mass *probably is electrical* and that *at zero velocity the mass would also be zero.* This gives us an entirely new conception of matter and electricity.

To understand how inertia may be due to electricity reference to Fig. 3, shows first an ion with only a single line of force represented. Second, an ion which has started to move is shown but only the part of the field near it has begun to move. It takes both *time* and *force* to get the whole system, the ion and its field, moving and this *resistance* is the *inertia* of the system.

This gives us a clue to finding the volume of an ion or any charged particle and in no other way can it be done. According to electro-statics the smaller the sphere on which a charge exists, the higher the potential so that any potential can be obtained by making the charge *concentrated* enough. In the case of the *electron,* in order to obtain a mass 1/1,800 of the hydrogen atom, the particle must have a volume of 1/100,000 that of a hydrogen atom, and this may rightly be termed the *electro-magnetic volume.*

(To be Concluded.)

ELECTRICITY AND RADIO AS USED BY "MOVIE" SPIES.

(Continued from page 299)

of the German Embassy, aroused the suspicions of the Secret Service. The change in plans was discovered before many shells had been manufactured under the false specifications.

The loading room of a munition factory was the place of attack chosen by Imperial German spies in case another plan in regard to the factory miscarried. An electric wire was installed by the head electrician in the plant, who was in German pay, which would throw a spark by the throwing in of a switch in the power house a safe distance away.

Slakberg, the ring-leader, is caught but throws away his cigar. The cigar is picked up by the electrician and in it he finds a note to blow up the works. He immediately jumps a freight bound for the factory. Unobserved he is followed by Miss Dixie Mason, a Secret Service operative, who tries to stop him from throwing the switch in the power-house. Running thru the works

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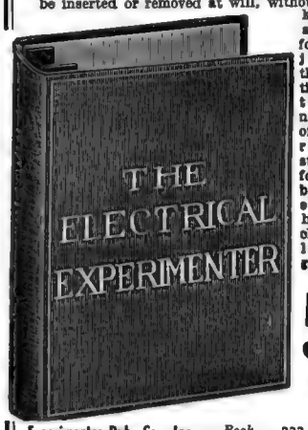

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she shouts a warning to the employes but arrives too late to save the switch from being thrown. A brief struggle ensues at the power-plant switchboard in which her arm is jammed in the switch by the electrician and the dirty work commences (see Fig 2). She faints and is found thus by the President of the Criminology Club who, altho he has begun to love the girl, imagines that she is also a spy, in that she is always with them. Little does he realize that she is also a Secret Service operative working "incognito" on special orders that he knows nothing about. Therefore, hearing some more explosions, he handcuffs her to the railing while he goes in pursuit. But always resourceful she manages to short-circuit the handcuffs with a tool and a rubber glove nearby, and by so doing melts the connecting link and gets free.

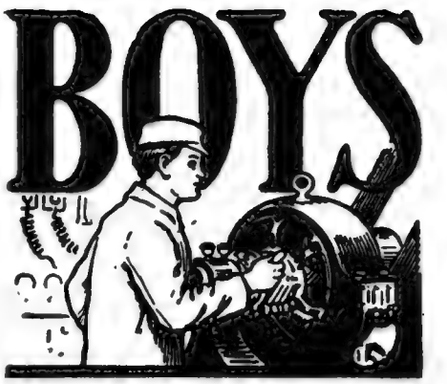
Next we have the daring "Raid of the U-53," which came to our shores and started a rumpus on which a quietus was soon put by our vigilant Navy. Dixie Mason, the young and pretty Secret Service operative, is trailing Captain Karl Boy-Ed, the former naval attaché of the Imperial German Embassy at Washington. He has returned to the United States in disguise after his dismissal as an envoy. Dixie is in a nearby place and witnesses a meeting between Boy-Ed and Commander Rose of the "U-53." She follows them to the dock where the submarine is lying. As a means of getting Boy-Ed on board without attracting attention the boat is suddenly opened to visitors and in the crowd which flocks on board Dixie easily follows Boy-Ed. She sees the former envoy secreted in a compartment, and she hides in a locker in the torpedo room. Unaware that Dixie is on board, the "U-53" puts to sea.

Dixie remains in her hiding place until the first torpedo fired in the raid on shipping has been trained on the Strathdene, a British freighter. She bursts from the locker and commands Rose to stop in the name of humanity. Sailors hold her while the torpedo is discharged and the Strathdene sent to destruction. Two more of the deadly weapons are fired from the submarine each finding a mark in the vitals of unprotected merchant vessels. Then she is released. The sailor who has had her in his grasp believes that a feigned weakness has been caused by her struggles. Instantly Dixie seizes a wrench and before she can be stopt has wrecked the remaining three torpedoes on the submarine by knocking the propellers off.

Orders are given to raise the U-boat to the surface, to continue the destruction of shipping with the deck guns. For a moment Dixie is left to her own devices and she sees a memoranda as to the location of a supply base for the submarine on the coast of Maine (see Fig 3). She rushes to the deck of the submarine and dives overboard with the object of swimming to a United States destroyer which is some distance away watching for any violation of neutrality on the part of the "U-53."

The episode ends with destroyers and aeroplanes searching for the supply base, under the direction of Grant, and Dixie, with information as to its location, swimming for the destroyer in the Atlantic Ocean.

Last, but not least, we have the superb photo-play production "Over the Top" with our great war hero Sergeant Guy Empey. Figure 4 shows an exciting moment from "Over the Top" in which a German Count and his accomplice at the switch-board of a tall office building somewhere in downtown New York, are about to throw the switch at midnight which will light a signal on top of the tower, notifying the other spies on the Jersey shore that it is time to begin blowing up munition factories and ships.



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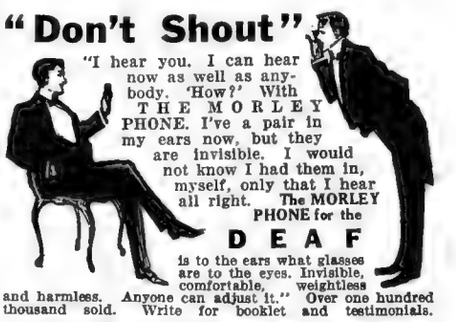

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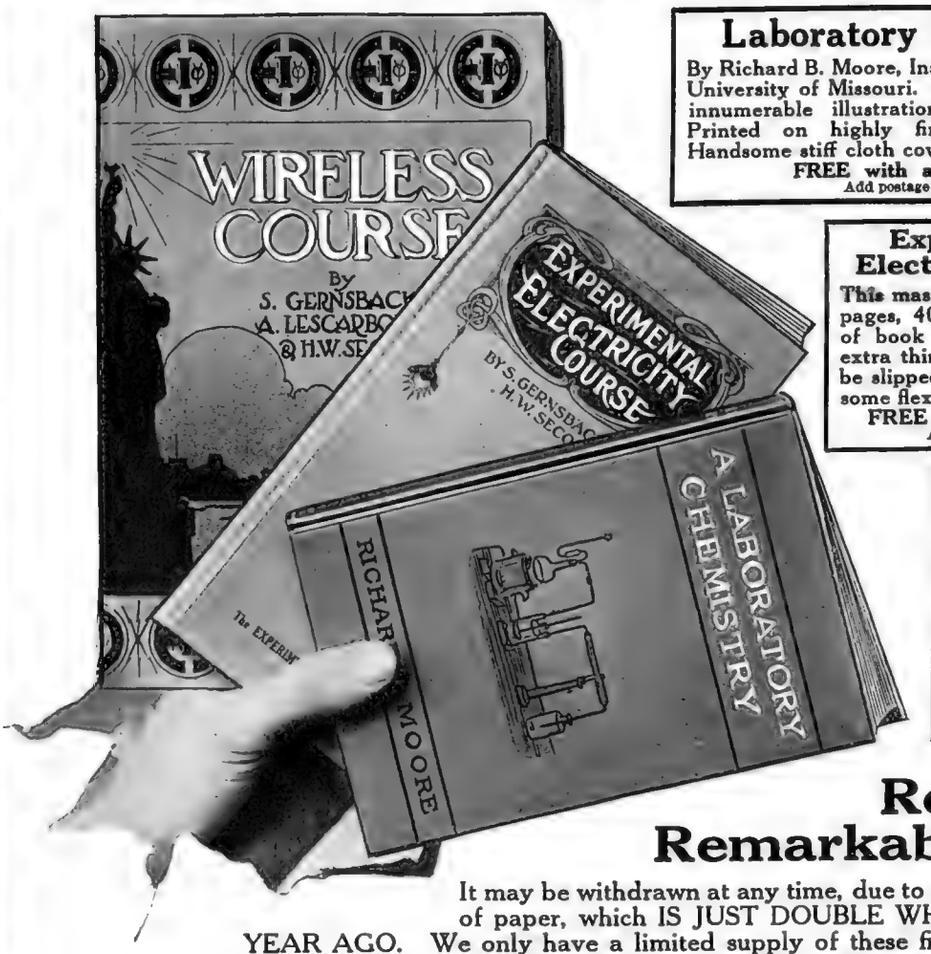

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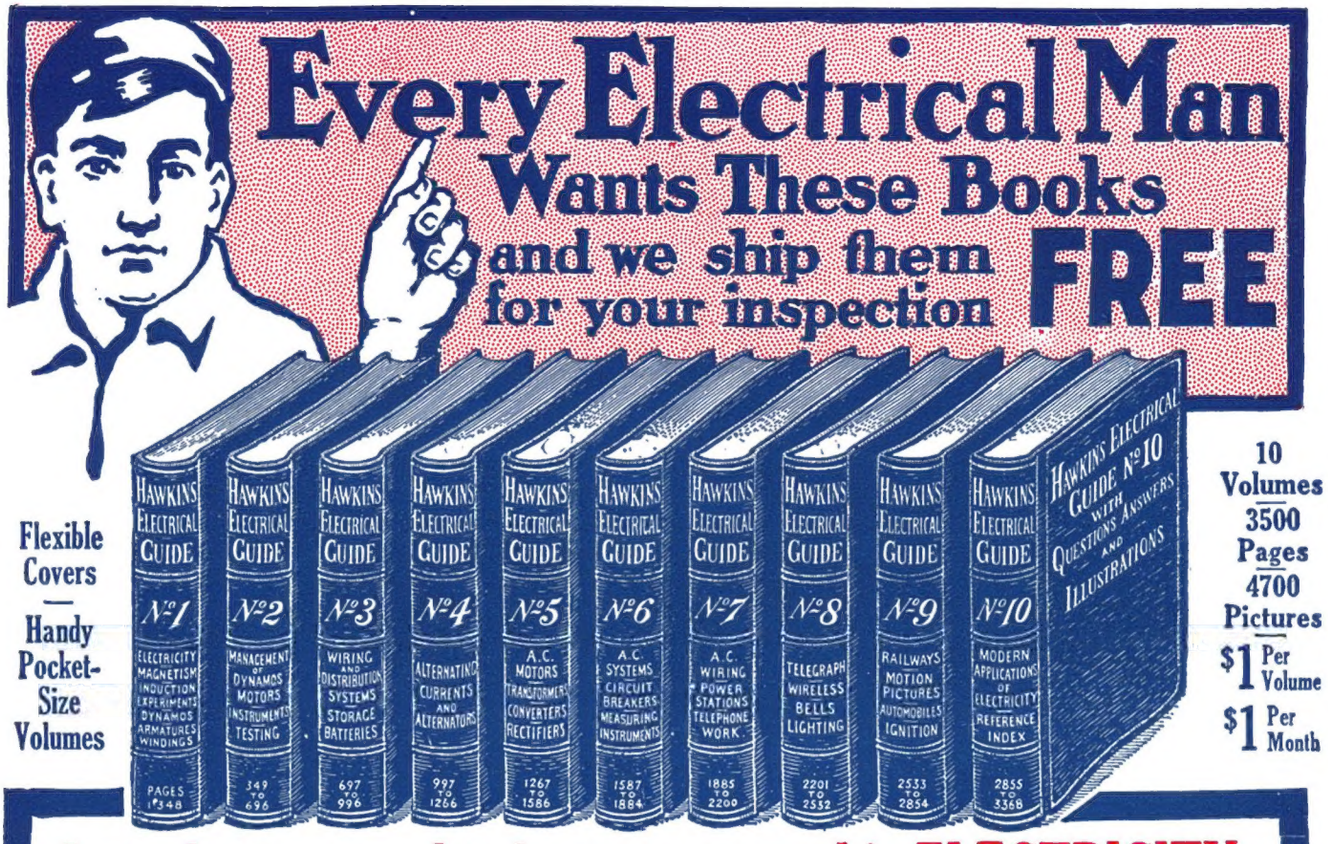
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